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Environmental Assessment of Utility Boiler Combustion Modification NOx Controls: Volume 2. Appendices

Acurex Corp. Mountain View, CA

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

Apr 80

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16. ABSTRACT

The report gives results of an evaluation of combustion modification techniques for coal-, oil-, and gas-fired utility boilers, with respect to NOx control reduction effectiveness, operational impact, thermal efficiency impact, capital and annualized operating costs, and effect on emissions of pollutants other than NOx. For gas- and oil-fired boilers, 30 to 60% NOx reductions are achievable with the combined use of staged combustion, flue gas recirculation, and low excess air at an annualized cost of $0.50 to $3.00/kW-yr. For retrofit control of existing coal-fired boilers, low NOx burners and/or staged combustion yields a 30 to 60% NOx reduction at an annualized cost of $0.40 to $1.20/kW-yr. For new sources, modified furnace design with low NOx burners and/or overfire air can achieve emission levels of 260 to 170 ng/J (40 to 60% reduction). Detailed emission tests on a 200 MW coal-fired boiler showed that changes in trace specie emissions due to combustion modifications were small compared to the benefit of reduced NOx emissions.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Air Pollution	Cost Effectiveness	Air Pollution Control	13B	14A
Assessments	Fossil Fuels	Stationary Sources	14B	21D
Combustion Control	Dust	Utility Boilers	21B	11G
Nitrogen Oxides	Aerosols	Combustion Modification	07B	07D
Boilers	Trace Elements	Particulate	13A	06A
Utilities	Organic Compounds	Environmental Assessment		07C

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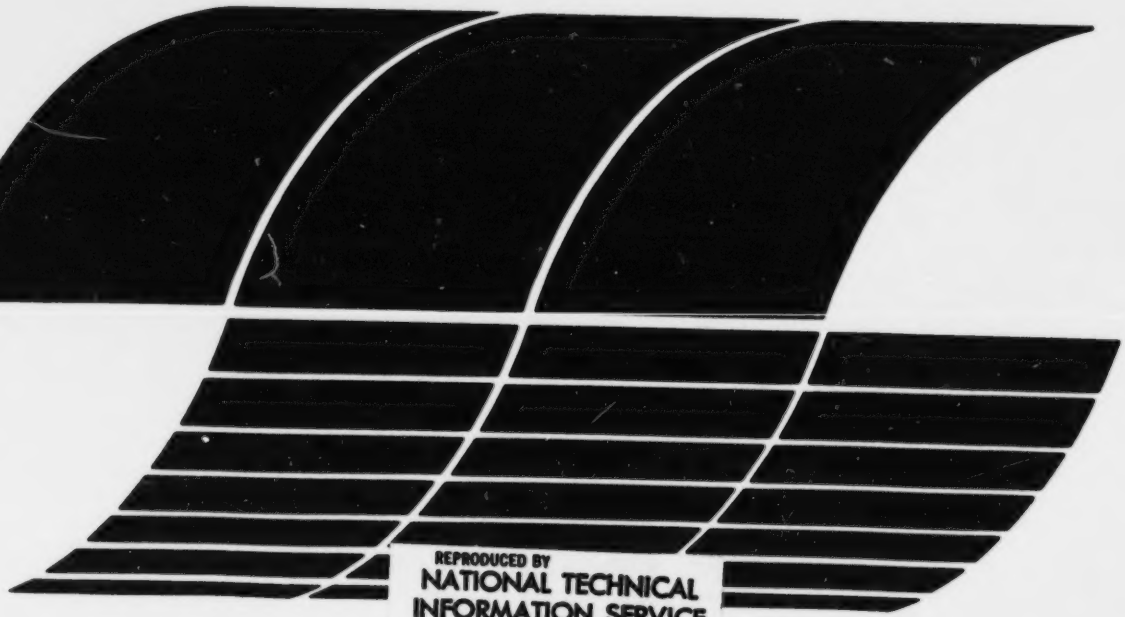

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EPA-600/7-80-075b

April 1980

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Washington, DC 20460

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The authors would also like to thank the following individuals for graciously supplying background and support information: J. Barsin and E. Campobenedetto of the Babcock and Wilcox Company; J. Vatsky of the Foster Wheeler Energy Corporation; W. Barr, F. Strehlitz, and E. Marble of the Pacific Gas and Electric Company; R. Meinzer of the San Diego Gas and Electric Company; G. A. Hollinden of the Tennessee Valley Authority; and W. Pepper of the Los Angeles Department of Water and Power.

PREFACE

This is the first in a series of five process engineering reports documented in the "Environmental Assessment of Stationary Source NO_x Combustion Modification Technologies" (NO_x EA). Specifically, this report documents the environmental assessment of NO_x combustion controls applied to utility boilers. The NO_x EA, a 36-month program which began in July 1976, is sponsored by the Combustion Research Branch of the Industrial and Environmental Research Laboratory of EPA (IERL-RTP). The program has two main objectives: (1) to identify the multimedia environmental impact of stationary combustion sources and NO_x combustion modification controls applied to these sources, and (2) to identify the most cost-effective, environmentally sound NO_x combustion modification controls for attaining and maintaining current and projected NO_2 air quality standards to the year 2000.

The NO_x EA is assessing the following combination of process parameters and environmental impacts:

- Major fuel combustion stationary NO_x sources: utility boilers, industrial boilers, gas turbines, internal combustion (IC) engines, and commmercial and residential warm air furnaces. Other sources (including mobile and noncombustion) will be considered only to the extent that they are needed to determine the NO_x contribution from stationary combustion sources.
- Conventional and alternate gaseous, liquid and solid fuels
- Combustion modification NO_x controls with potential for implementation to the year 2000; other controls (flue gas cleaning, mobile controls) will be considered only to estimate the future need for combustion modifications

- Source effluent streams potentially affected by NO_x controls
- Primary and secondary gaseous, liquid and solid pollutants potentially affected by NO_x controls
- Pollutant impacts on human health and terrestrial or aquatic ecology

To achieve the objectives discussed above, the NO_x EA program approach is structured as shown schematically in Figure P-1. The two major tasks are: Environmental Assessment and Process Engineering (Task B5), and Systems Analysis (Task C). Each of these tasks is designed to achieve one of the overall objectives of the NO_x EA program cited earlier. In Task B5, of which this report is a part, the environmental, economic, and operational impacts of specific source/control combinations are evaluated. On the basis of this assessment, the incremental multimedia impacts from the use of combustion modification NO_x controls will be identified and ranked. Systems analysis in turn uses the results of Task B5 to identify and rank the most effective source/control combinations to comply, on a local basis, with the current NO_2 air quality standards and projected NO_2 related standards.

As shown in Figure P-1, the key tasks supporting Tasks B5 and C are Baseline Emissions Characterization (Task B1), Evaluation of Emission Impacts and Standards (Task B2), Experimental Testing (Task B3), and Source Analysis Modeling (Task D). The arrows in Figure P-1 show the sequence of subtasks and the major interactions among the tasks. The oval symbols identify the major outputs of each task. The subtasks under each main task are shown on the figure from the top to the bottom of the page in roughly the same order in which they will be carried out.

As indicated above, this report is a part of the Process Engineering and Environmental Assessment Task. The goal of this task is to generate process evaluations and environmental assessments for specific source/control combinations. These studies will be done in order of descending priority. In the first year of the NO_x EA, all the sources and controls involved in current and planned NO_x control implementation programs were investigated. The "Preliminary Environmental Assessment of Combustion Modification Techniques" (Reference P-1) documented this effort and established a priority ranking based on source emission impact and

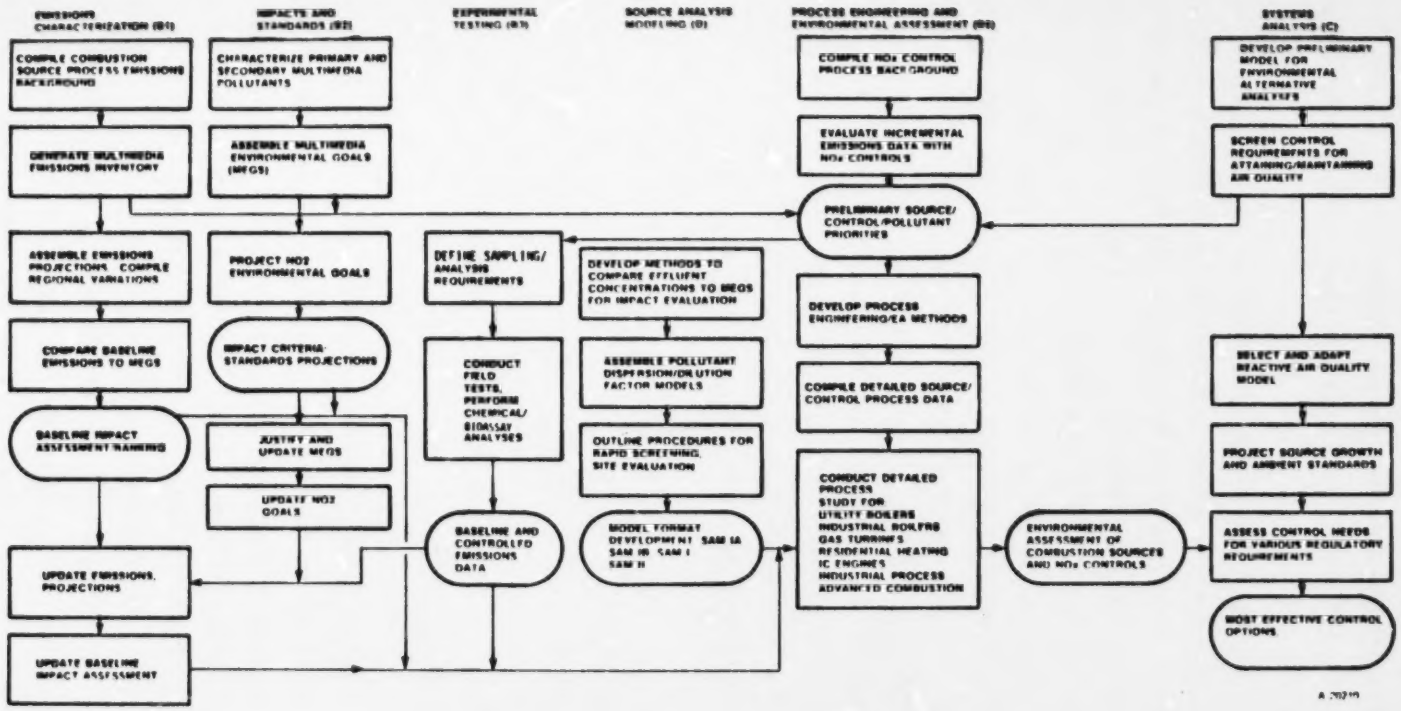

Figure P-1. NO_x EA approach.

potential for effective NO_x control, to be used in the current ongoing detailed evaluation.

This report presents the assessment of combustion modification NO_x controls for the first source category to be treated, utility boilers. Other environmental assessment reports documented are:

- Environmental Assessment of Industrial Boiler Combustion Modification NO_x Controls (Reference P-2)
- Environmental Assessment of Combustion Modification Controls for Stationary Gas Turbines (Reference P-3)
- Environmental Assessment of Combustion Modification Controls for Stationary Internal Combustion Engines (Reference P-4)
- Environmental Assessment of Combustion Modification Controls for Residential and Commercial Heating Systems (Reference P-5)

REFERENCES FOR PREFACE

P-1. Mason, H. B., et al., "Preliminary Environmental Assessment of Combustion Modification Techniques. Volume II: Technical Results," EPA-600/7-77-119b, NTIS-PB 276 681/AS, October 1977.

P-2. Lim, K. J., et al., "Environmental Assessment of Industrial Boiler Combustion Modification NO_x Controls," Acurex Draft Report TR-79-10/EE, EPA Contract 68-02-2160, Acurex Corp., Mountain View, CA, June 1979.

P-3. Larkin, R., et al., "Environmental Assessment of Combustion Modification Controls for Stationary Gas Turbines," Acurex Draft Report TR-79-18/EE, EPA Contract 68-02-2160, Acurex Corp., Mountain View, CA, June 1980.

P-4. Lips, H. I., et al., "Environmental Assessment of Combustion Modification Controls for Stationary Reciprocating Internal Combustion Engines," Acurex Draft Report TR-79-14/EE, EPA Contract 68-02-2160, Acurex Corp., Mountain View, CA, July 1979.

P-5 Castaldini, et al., "Environmental Assessment of Combustion Modification Controls for Residential and Commercial Heating Systems," Acurex Draft Report TR-79-17/EE, EPA Contract 68-02-2160, Acurex Corp., Mountain View, CA, September 1979.

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APPENDIX A

NO_x CONTROL DATA FROM BABCOCK & WILCOX COMPANY

All four major boiler manufacturers were invited to submit process data to aid in the assessment of NO_x control technology. For those who did respond, their replies are provided here in Appendix A and in Appendix B.

The information presented in this appendix was graciously supplied by the Babcock & Wilcox Company of Barberton, Ohio to aid in the NO_x control assessment. It is reproduced here in its entirety.

Babcock & Wilcox

Power Generation Group
Barberton, Ohio 44203
Telephone (216) 753-4511

November 15, 1977

Mr. Ken Lim
Acurex/Aerotherm
485 Clyde Avenue
Mountain View, CA 94042

Dear Ken:

In response to your request for information to complete your environmental assessment contract with the EPA, the following information is provided as a review of the Babcock And Wilcox Company achievements in NO_x control.

A. TECHNICAL PAPERS

"The Dual Register Pulverized Coal Burner - Field Test Results", E. J. Campobenedetto

"The Dual Register Pulverized Coal Burner", J. A. Barsin

"NO_x Formation In Premixed Combustion: A Kinetic Model And Experimental Data", H. B. Lange, Jr.

"Nitric Oxide Control For Oil And Gas Fired Utility Boilers", D. E. James

"Effect Of Coal And Multi-Fuel Firing On Industrial Boiler Design", J. D. Blue

"Nitric Oxide Control - A Program Of Significant Accomplishments", W. H. Barr and D. E. James

"Nitric Oxide Reduction Through Controlled Combustion - A Challenge To The Boiler Designer", B. C. Krippene

"Burner And Boiler Alterations For NO_x Control", B. C. Krippene

"The Effect Of Design And Operation Variables On NO_x Formation In Coal Fired Furnaces: Status Report", W. J. Armento and W. L. Sage

"Control Of NO_x In Power Plant Operations", W. H. Barr

"Liquid Fuel Analysis - Their Effect On Combustion And Emissions", G. H. Weidman and P. M. Utterback

"Pulverized Coal - New Requirements And Challenges", O. W. Durrant

"Design Of Large Coal Fired Steam Generators", K. H. Haller

"A Boiler Manufacturer's View On Nitric Oxide Formation", D. E. James

"Design Considerations For NO_x Control Of Natural Gas - Fired Power Boilers", B. C. Krippene

B. DESIGN COMPARISON

Prior to enactment of the New Source Performance Standards, modifications were made to units to decrease the slagging potential in the furnace. The major design change was a reduction in heat input to furnace plan area from an average of 2.1×10^6 BTU/sq. ft. hr. to about 1.8×10^6 BTU/sq. ft. hr. This change, which took place in 1970, also helped to reduce NO_x emissions.

A comparison of a unit designed with the above liberal heat release per plan, but prior to the NSPS with a unit designed to control NO_x emissions to meet the current NSPS levels indicate very little change outside of the burner zone. Attached are copies of Performance Summary Sheets and Sectional Side Views for two typical eastern fuel-fired units. Unit No. 1 was sold prior to the NSPS (no NO_x guarantee) and Unit No. 2 was sold to meet the NSPS NO_x limit of 0.7 lbs/10^6BTU.

Both units are identical in physical size and steam generating capacity. The design differences were included in Unit No. 2 for NO_x control. The differences include:

1. Replacing the high turbulence, rapid mixing cell burner with the limited turbulence dual register burner,

2. Increasing the burner zone by spreading the burners vertically to include 22% more furnace surface, and

3. Metering and controlling the air flow to each row of burners with a compartmented windbox.

To provide these changes for NO_x control, the price increase was about $1.75 - $2.50/KW.

Overfire air ports were also included on Unit No. 2 since NO_x data for the dual register burner was not available at the time the unit was designed. To account for the five (5) percent excess air required to cool the ports, the total excess air at full load was increased from 20% to 22%.

C. NO_x REDUCTION TECHNIQUES - OIL FIRING

Over the past years, B&W has been involved in a wide variety of NO_x reduction programs on oil-fired units. The majority of these programs have included utilizing one or more NO_x control techniques. The methods used are dependent on the size, and age of the unit as well as the final level of NO_x to be achieved. The following is a list of NO_x control methods applicable to new units or as retrofit solutions to meet increasingly lower NO_x levels.

1. Burner Zone Sizing

This is applicable to new units only. NO_x emissions can be decreased by reducing the quantity of heat released per square foot of cooling surface in the burner zone. For a decrease of 40% in heat release rate, NO_x can be reduced by up to 100ppm. This decrease in heat release rate is achieved by spreading the burners through larger vertical spacings.

2. Burner Design

This NO_x control technique can be applied to both new and existing units. Based on NO_x reductions of up to 50% on P.C. firing with the dual register burner, a similiar concept has been applied to oil fired units. Data from an oil-fired unit retrofitted with this burner has shown a 20-30% reduction in NO_x formation through controlled air and fuelmixing at each burner. However, this method is costly and may not be applicable on small units. Also, depending on the remaining life of the unit and the number of burners to be retrofitted, this method may not be cost effective.

3. Gas Recirculation

The gas recirculation is effective on new units designed to handle the additional mass flow of the recirculated flue gas. On units recently tested, a 25-30% reduction in NO_x was achieved utilizing gas recirculation through the windbox or furnace hopper. The above reduction is based on a base line condition with the gas recirculation fans out of service.

Gas recirculation can also be used as a retrofit for NO_x reductions. However, based on test results, NO_x reductions are not as pronounced as for new units. NO_x reductions of up to 20% have been obtained depending on the base line NO_x emissions and the size of the furnace. It appears that the increased mixing and turbulence caused by the additional mass flow limits the NO_x reductions. Again, the cost effectiveness of this technique should be compared to other methods of NO_x control for each specific application.

4. Two-Stage Combustion

Two stage combustion using NO_x ports is an effective method of NO_x reduction. NO_x reductions of up to 50% have been achieved by using NO_x ports. However, this type of firing requires special attention for several reasons:

1. The mixing of fuel and air must be maximized to prevent both smoking and excessive CO emissions,

2. To maintain adequate mixing normally requires additional quantities of excess air to prevent smoking, and

3. There is an increased potential for lower furnace tube wastage when burning high sulfur oil under sub-stoichiometric conditions. The above will add additional operating and maintenance costs to a unit designed with ports.

The above problems also exist when a unit is retrofitted for two staging. Mixing becomes a problem due to the reduced burner pressure drop with the 15-25% reduction in air flow to the burners. In addition, some units may not have the required furnace height to add ports eight (8) feet above the top row of burners. The cost of this retrofit includes not only the NO_x ports, but also the additional windbox and flues required to get air flow to this elevation of the furnace.

5. Burners Out Of Service (BOOS)

This method of off-stoichiometric firing requires little, if any, boiler modification. BOOS can be applied to both new and existing units as an effective NO_x control technique. BOOS consists of removing one or more selected burners from oil service and admitting air through the idle burner(s). NO_x reduction of up to 35% can be achieved while manitaining acceptable levels of CO (less than 100ppm).

This method of NO_x reduction would require testing the unit in question to establish the BOOS pattern that most effectively reduces NO_x while maintaining acceptable operating conditions. Depending on the capacity of the existing burners, the only modification necessary would be a change of sprayer plate size to permit full load operation with one or more burners out of service. This method of off-stoichiometric firing keeps the combustion air in the burner zone where it is most effective for combustion.

6. Low Excess Air Operation

This method is very cost effective as well as an effective NO_x control device. For each five (5) percent reduction in excess air to the burners a 25-35ppm reduction in NO_x is obtained. Depending on the burner used, it is possible to reduce the excess air to the burner to %5 with acceptable CO emissions. Excess air levels as low as 3% to the burners have been achieved during recent testing.

7. Change Of Oil Supply

The amount of nitrogen in the fuel oil directly affects the NO_x emissions. Laboratory tests indicate that about 50% of the total NO_x is attributable to fuel bound nitrogen. The nitrogen in oil can vary from 0.1% N to 1.0% N by weight and above. On a given unit, NO_x can be decreased by 15-25ppm per 0.1% decrease in fuel nitrogen content.

The above control techniques are not additive. However, it is normally possible to apply a combination of the above methods to optimize NO_x reductions. Before a decision can be made as to the optimum combination for lowest NO_x, each specific unit must be reviewed regarding age, size, base line NO_x emissions, and the final NO_x emission level required.

D. PACIFIC GAS AND ELECTRIC DATA

The data you requested regarding the Pacific Gas And Electric Company's boilers retrofitted for NO_x control will be forwarded to you through Mr. W. H. Barr of Pacific Gas And Electric as requested in his letter of October 20, 1977.

After you review the above information, please call me if you have any other questions concerning Babcock & Wilcox's experience in NO_x control.

The above has been submitted to Acurex/Aerotherm with the understanding that Babcock & Wilcox will reserve the right to review and approve or edit the final report with regard to any information submitted by Babcock & Wilcox under this project.

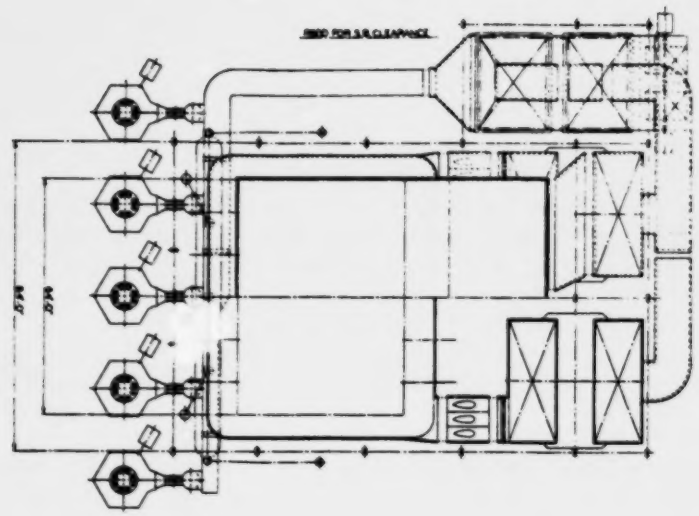
Very Sincerely yours,

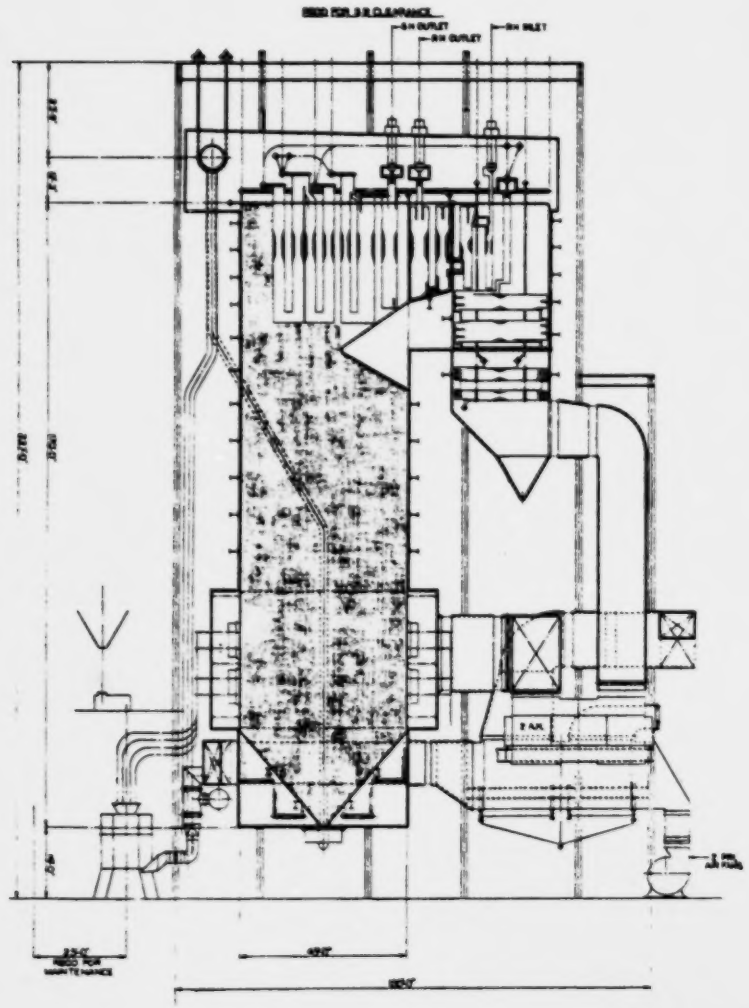
E. J. Campobenedetto

E. J. Campobenedetto,
Combustion Systems

EJC:er

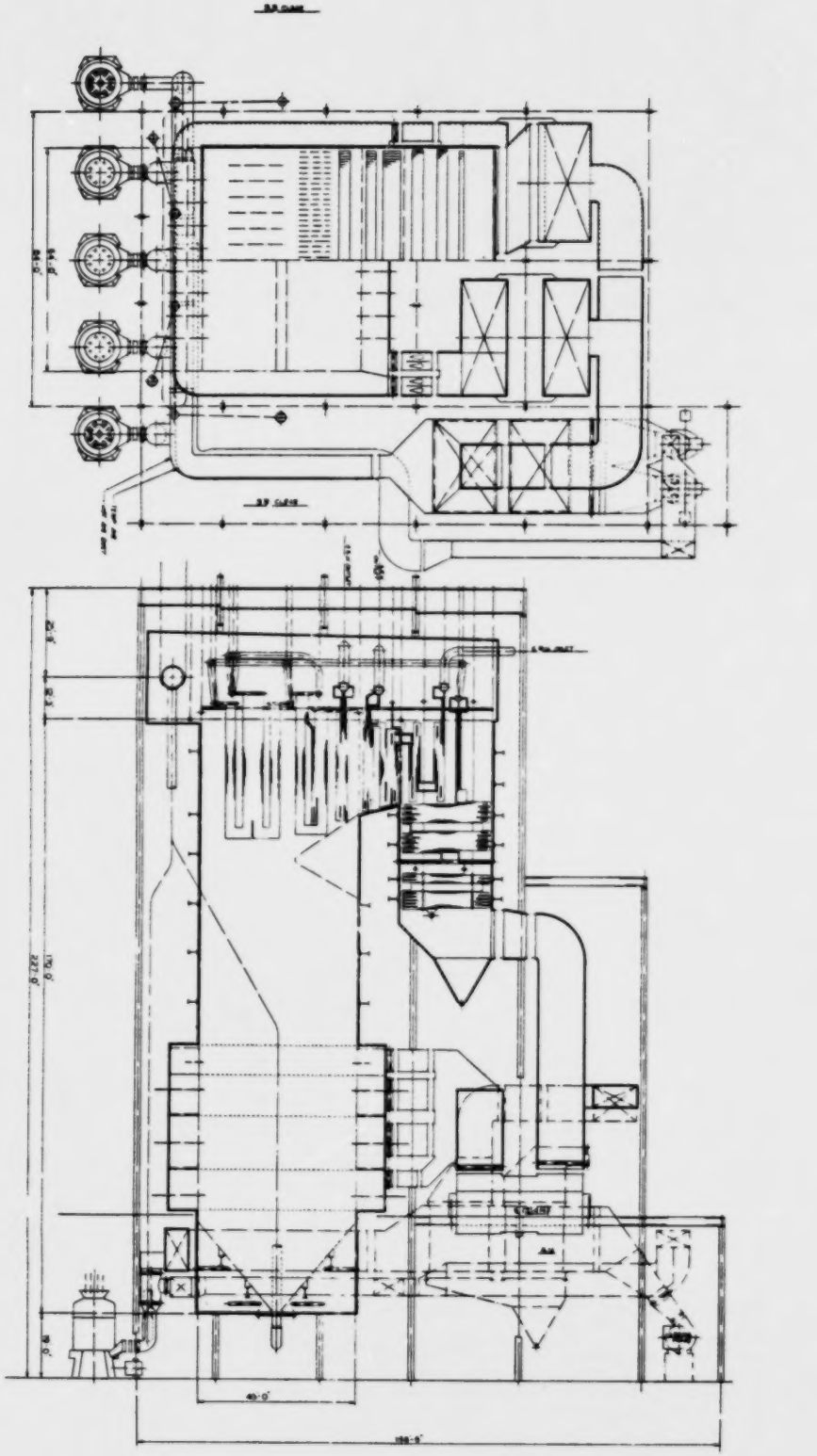
CC: G.W. Bouton
A.M. Frendberg
L.W. Yoder





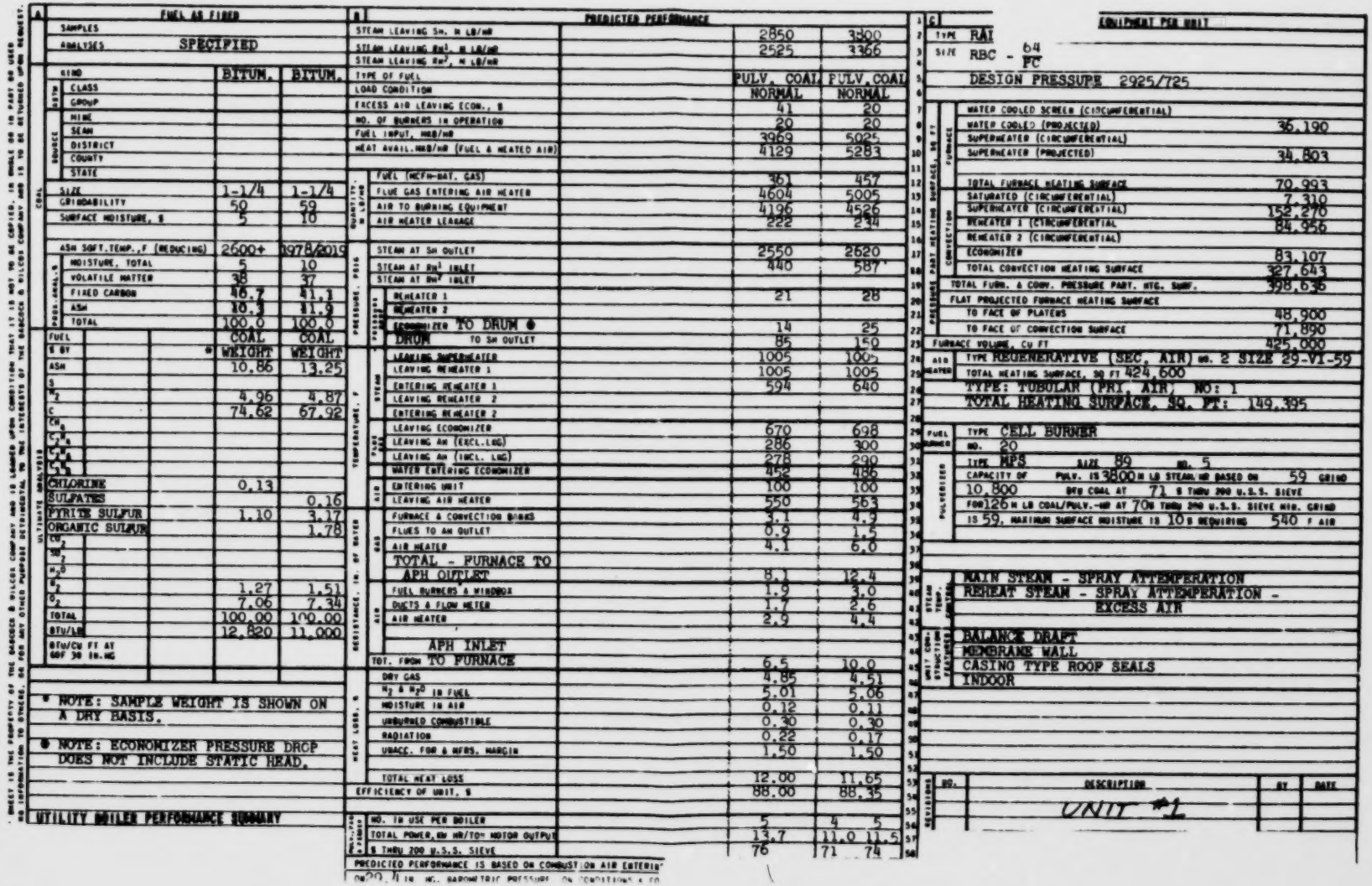
UNIT #1

Babcock & Wilcox
POWER GENERATION DIVISION



UNIT #2

Babcock & Wilcox
POWER GENERATION GROUP



A — FUEL AS FIRED		
SAMPLES		
ANALYSES	SPECIFIED	
COAL — KIND	BITUM.	BITUM.
COAL — CLASS		
COAL — GROUP		
COAL — MINE		
COAL — SEAM		
COAL — DISTRICT		
COAL — COUNTY		
COAL — STATE		
SIZE	1-1/4	1-1/4
GRINDABILITY	50	50
SURFACE MOISTURE, %	5	10
ASH SOFT. TEMP., F (REDUCING)	2600+	2978/2019
PROX. ANAL., % — MOISTURE, TOTAL	5	10
PROX. ANAL., % — VOLATILE MATTER	38	37
PROX. ANAL., % — FIXED CARBON	46.7	41.1
PROX. ANAL., % — ASH	10.3	11.9
PROX. ANAL., % — TOTAL	100.0	100.0
ULTIMATE ANALYSIS — FUEL	COAL	COAL
ULTIMATE ANALYSIS — AS BY	* WEIGHT	WEIGHT
ULTIMATE ANALYSIS — ASH	10.86	13.25
ULTIMATE ANALYSIS — S		
ULTIMATE ANALYSIS — H_2	4.96	4.87
ULTIMATE ANALYSIS — C	74.62	67.92
ULTIMATE ANALYSIS — CH_4		
ULTIMATE ANALYSIS — C_2H_6		
ULTIMATE ANALYSIS — C_3H_8		
ULTIMATE ANALYSIS — C_4H_{10}		
ULTIMATE ANALYSIS — CHLORINE	0.13	
ULTIMATE ANALYSIS — SULFATES		0.16
ULTIMATE ANALYSIS — PYRITIC SULFUR	1.10	3.17
ULTIMATE ANALYSIS — ORGANIC SULFUR		1.78
ULTIMATE ANALYSIS — CO_2		
ULTIMATE ANALYSIS — SO_2		
ULTIMATE ANALYSIS — H_2O		
ULTIMATE ANALYSIS — N_2	1.27	1.51
ULTIMATE ANALYSIS — O_2	7.06	7.34
ULTIMATE ANALYSIS — TOTAL	100.00	100.00
BTU/LB	12,820	11,000
BTU/CU FT AT 60F 30 IN. HG		

* NOTE: SAMPLE WEIGHT IS SHOWN ON A DRY BASIS.

● NOTE: ECONOMIZER PRESSURE DROP DOES NOT INCLUDE STATIC HEAD.

UTILITY BOILER PERFORMANCE SUMMARY

B — PREDICTED PERFORMANCE			
STEAM LEAVING Sh, M LB/HR		2850	3300
STEAM LEAVING Rh^1, M LB/HR		2525	3366
STEAM LEAVING Rh^2, M LB/HR			
TYPE OF FUEL		PULV. COAL	PULV. COAL
LOAD CONDITION		NORMAL	NORMAL
EXCESS AIR LEAVING ECON., %		41	20
NO. OF BURNERS IN OPERATION		20	20
FUEL INPUT, MMB/HR		3969	5025
HEAT AVAIL. MMB/HR (FUEL & HEATED AIR)		4129	5283
QUANTITIES, M LB/HR — FUEL (MCFH-NAT. GAS)		361	457
QUANTITIES, M LB/HR — FLUE GAS ENTERING AIR HEATER		4604	5005
QUANTITIES, M LB/HR — AIR TO BURNING EQUIPMENT		4196	4526
QUANTITIES, M LB/HR — AIR HEATER LEAKAGE		222	234
PRESSURE, PSIG — STEAM AT Sh OUTLET		2550	2620
PRESSURE, PSIG — STEAM AT Rh^1 INLET		440	587
PRESSURE, PSIG — STEAM AT Rh^2 INLET			
PRESSURE DROP — REHEATER 1		21	28
PRESSURE DROP — REHEATER 2			
PRESSURE DROP — ECONOMIZER TO DRUM ●		14	25
PRESSURE DROP — DRUM TO Sh OUTLET		85	150
TEMPERATURE, F — STEAM — LEAVING SUPERHEATER		1005	1005
TEMPERATURE, F — STEAM — LEAVING REHEATER 1		1005	1005
TEMPERATURE, F — STEAM — ENTERING REHEATER 1		594	640
TEMPERATURE, F — STEAM — LEAVING REHEATER 2			
TEMPERATURE, F — STEAM — ENTERING REHEATER 2			
TEMPERATURE, F — FLUE GAS — LEAVING ECONOMIZER		670	698
TEMPERATURE, F — FLUE GAS — LEAVING AH (EXCL. LKG)		286	300
TEMPERATURE, F — FLUE GAS — LEAVING AH (INCL. LKG)		278	290
TEMPERATURE, F — AIR — WATER ENTERING ECONOMIZER		462	486
TEMPERATURE, F — AIR — ENTERING UNIT		100	100
TEMPERATURE, F — AIR — LEAVING AIR HEATER		550	563
RESISTANCES, IN. OF WATER — GAS — FURNACE & CONVECTION BANKS		3.1	4.9
RESISTANCES, IN. OF WATER — GAS — FLUES TO AH OUTLET		0.9	1.5
RESISTANCES, IN. OF WATER — GAS — AIR HEATER		4.1	6.0
RESISTANCES, IN. OF WATER — GAS — TOTAL - FURNACE TO APH OUTLET		8.1	12.4
RESISTANCES, IN. OF WATER — AIR — FUEL BURNERS & WINDBOX		1.6	3.0
RESISTANCES, IN. OF WATER — AIR — DUCTS & FLOW METER		1.7	2.6
RESISTANCES, IN. OF WATER — AIR — AIR HEATER		2.9	4.4
RESISTANCES, IN. OF WATER — AIR — APH INLET TOT. FROM TO FURNACE		6.5	10.0
HEAT LOSS, % — DRY GAS		4.85	4.51
HEAT LOSS, % — H_2 & H_2O IN FUEL		5.01	5.06
HEAT LOSS, % — MOISTURE IN AIR		0.12	0.11
HEAT LOSS, % — UNBURNED COMBUSTIBLE		0.30	0.30
HEAT LOSS, % — RADIATION		0.22	0.17
HEAT LOSS, % — UBACC. FOR & MFRS. MARGIN		1.50	1.50
TOTAL HEAT LOSS		12.00	11.65
EFFICIENCY OF UNIT, %		88.00	88.35
PULVERIZERS — NO. IN USE PER BOILER		5	4 5
PULVERIZERS — TOTAL POWER, KW HR/TON MOTOR OUTPUT		13.7	11.0 11.5
PULVERIZERS — % THRU 200 U.S.S. SIEVE		76	71 74

PREDICTED PERFORMANCE IS BASED ON COMBUSTION AIR ENTERING AT 29.92 IN. HG. BAROMETRIC PRESSURE, DRY CONDITIONS & 80

C — EQUIPMENT PER UNIT	
TYPE	RAI
SIZE	RBC - 64 FC
DESIGN PRESSURE	2925/725
FURNACE PRESSURE PART HEATING SURFACES, SQ FT — WATER COOLED SCREEN (CIRCUMFERENTIAL)	
FURNACE — WATER COOLED (PROJECTED)	36,190
FURNACE — SUPERHEATER (CIRCUMFERENTIAL)	
FURNACE — SUPERHEATER (PROJECTED)	34,803
FURNACE — TOTAL FURNACE HEATING SURFACE	70,993
CONVECTION — SATURATED (CIRCUMFERENTIAL)	7,310
CONVECTION — SUPERHEATER (CIRCUMFERENTIAL)	152,276
CONVECTION — REHEATER 1 (CIRCUMFERENTIAL)	84,956
CONVECTION — REHEATER 2 (CIRCUMFERENTIAL)	
CONVECTION — ECONOMIZER	83,107
CONVECTION — TOTAL CONVECTION HEATING SURFACE	327,643
TOTAL FURN. & CONV. PRESSURE PART. HTG. SURF.	398,636
FLAT PROJECTED FURNACE HEATING SURFACE — TO FACE OF PLATENS	48,900
FLAT PROJECTED FURNACE HEATING SURFACE — TO FACE OF CONVECTION SURFACE	71,890
FURNACE VOLUME, CU FT	425,000
AIR HEATER	TYPE REGENERATIVE (SEC. AIR) no. 2 SIZE 29-VI-59
AIR HEATER	TOTAL HEATING SURFACE, SQ FT 424,600
AIR HEATER	TYPE: TUBULAR (PRI. AIR) NO: 1
AIR HEATER	TOTAL HEATING SURFACE, SQ. FT: 149,395
FUEL BURNED — TYPE	CELL BURNER
FUEL BURNED — NO.	20
PULVERIZER — TYPE MPS SIZE 89 NO. 5	
PULVERIZER — CAPACITY OF PULV. IS 3800 M LB STEAM/HR BASED ON 59 GRIND	
PULVERIZER — 10,800 DRY COAL AT 71 % THRU 200 U.S.S. SIEVE	
PULVERIZER — FOR 126 M LB COAL/PULV.-HR AT 70 % THRU 200 U.S.S. SIEVE MIN. GRIND	
PULVERIZER — IS 59, MAXIMUM SURFACE MOISTURE IS 10 % REQUIRING 540 ° AIR	
STEAM TEMP. CONTROL — MAIN STEAM - SPRAY ATTEMPERATION	
STEAM TEMP. CONTROL — REHEAT STEAM - SPRAY ATTEMPERATION - EXCESS AIR	
UNIT CONSTRUCTION FEATURES — BALANCE DRAFT	
UNIT CONSTRUCTION FEATURES — MEMBRANE WALL	
UNIT CONSTRUCTION FEATURES — CASING TYPE ROOF SEALS	
UNIT CONSTRUCTION FEATURES — INDOOR	

REVISIONS — NO.	DESCRIPTION	BY	DATE
	UNIT #1		

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A — FUEL AS FIRED

SAMPLES		
ANALYSES		
COAL SOURCE — MINE		
SEAM		
DISTRICT		
COUNTY		
STATE		
SIZE	1¼	1¼
GRINDABILITY	50	50
SURFACE MOISTURE, %	5	10
ASH SOFT. TEMP., F (REDUCING)	2600+	1978/2019
PROX. ANAL. % — MOISTURE, TOTAL	5	10
VOLATILE MATTER	38	37
FIXED CARBON	46.7	41.1
ASH	10.3	11.9
TOTAL	100.0	100.0
FUEL	COAL	COAL
ULTIMATE ANALYSIS — AS FIRED	WT. DRY	WT. DRY
ASH	10.86	13.25
S		
H_2	4.96	4.87
C	74.62	67.32
N_2		
O_2		
CHLORINE	0.13	
SULFATES		0.16
PYRITE SULFUR	1.10	3.17
ORGANIC SULFUR		1.78
CO_2		
SO_2		
N_2		
H_2O		
O_2	1.27	1.51
TOTAL	7.06	7.34
BTU/LB	100.00	100.00
BTU/CU FT AT 60F TO IN.HG	12,826	11,000

① ECON. PRESSURE DROP DOES NOT INCLUDE STATIC HEAD.

UTILITY BOILER PERFORMANCE SUMMARY

B — PREDICTED PERFORMANCE

STEAM FLOW, GR. W LB/HR	2850	3800
STEAM LEAVING Pn^2, # LB/HR	2525	3366
STEAM LEAVING Rn^2, # LB/HR		
TYPE OF FUEL	PULVERIZED COAL	
LOAD CONDITION	NORMAL	MAX.
EXCESS AIR LEAVING ECON., %	41	22
NO. OF BURNERS IN OPERATION	20	20
FUEL INPUT, MAB'H	3375	5025
HEAT AVAIL. MAB'H (FUEL & HEATED AIR)	4232	5300
QUANTITY, LB/HR — FUEL (MCF=NAT. GAS)	301	457
FLUE GAS ENTERING AIR HEATER	4440	5160
AIR TO BURNING EQUIPMENT	4200	4675
AIR HEATER LEAKAGE	238	245
PRESSURE, PSIG — STEAM AT SH OUTLET	2520	2620
STEAM AT Rn^2 OUTLET	440	537
STEAM AT Rn^2 INLET		
PRESSURE DROP — REHEATER 1	22	32
REHEATER 2		
ECONOMIZER TO DRUM ①	11	21
DRUM TO SH OUTLET	87	156
TEMPERATURE, F — STEAM — LEAVING SUPERHEATER	1005	1005
LEAVING REHEATER 1	1005	1005
ENTERING REHEATER 1	598	640
LEAVING REHEATER 2		
ENTERING REHEATER 2		
FLUE GAS — LEAVING ECONOMIZER	670	698
LEAVING AH (FULL LOAD)	286	300
LEAVING AH (TUNE UP)	278	290
WATER ENTERING ECONOMIZER	462	496
AIR — ENTERING UNIT	100	100
LEAVING AIR HEATER	560	563
RESISTANCE, IN. OF WATER — GAS — FURNACE & CONVECTION BANKS	4.2	5.2
FLUES TO AH OUTLET	1.2	1.4
AIR HEATER	5.1	6.3
TOT. FURN. TO APH OUT	10.5	12.9
AIR — FUEL BURNERS & WINDBOX	1.6	2.0
DUCTS & FLOW METER	2.8	3.4
AIR HEATER	3.3	4.6
TOT. FROM APH IN. TO FURN.	7.7	10.0
HEAT LOSS, % — DRY GAS	4.80	4.45
H_2 & H_2O IN FUEL	5.01	5.02
MOISTURE IN AIR	0.12	0.12
UNBURNED COMBUSTIBLE	0.30	0.30
RADIATION	0.22	0.17
UNACC. FOR & MFRS. MARGIN	1.50	1.50
TOTAL HEAT LOSS	12.00	11.76
EFFICIENCY OF UNIT, %	88.00	88.24
PULVERIZER DESIGN — NO. IN USE PER BOILER	5	5
TOTAL POWER, KW MOTOR OUTPUT	13.7	11.5
% THRU 200 U.S.S. SIEVE	76	74

PREDICTED PERFORMANCE IS BASED ON COMBUSTION AIR ENTERING AT 27.4 DEG. BAROMETRIC PRESSURE, ON CONDITIONS & EQUIPMENT AS SHOWN ON DRAWING

C — EQUIPMENT PER UNIT

TYPE RADIANT BOILER

SIZE RBC 64/PC

DESIGN PRESSURE 2925/725

FURNACE — WATER COOLED SURFACE, SQ FT — WATER COOLED SCREEN (CIRCUMFERENTIAL)		
WATER COOLED (PROJECTED)	36,190	
SUPERHEATER (CIRCUMFERENTIAL)		
SUPERHEATER (PROJECTED)	34,803	
TOTAL FURNACE HEATING SURFACE	70,993	
CONVECTION — SATURATED (CIRCUMFERENTIAL)	7,310	
SUPERHEATER (CIRCUMFERENTIAL)	152,270	
REHEATER 1 (CIRCUMFERENTIAL)	84,466	
REHEATER 2 (CIRCUMFERENTIAL)		
ECONOMIZER	83,107	
TOTAL CONVECTION HEATING SURFACE	327,643	
TOTAL FURN. & CONV. PRESSURE PART. HTG. SURF.	398,636	
FLAT PROJECTED FURNACE HEATING SURFACE — TO FACE OF PLATENS	48,300	
TO FACE OF CONVECTION SURFACE	71,890	
FURNACE VOLUME, CU FT	425,000	

AIR HEATER — TYPE SEC. AIR REGENERATIVE NO. 2 SIZE 29-VI-59

TOTAL HEATING SURFACE, SQ FT 424,600

PRI. AH: TUBULAR NO. 1

TOTAL HEATING SURFACE, SQ. FT. 149,335

FUEL BURNER — TYPE [redacted] DUAL REGISTER

NO. 40

PULVERIZER — TYPE MPS SIZE 89 NO. 5

CAPACITY OF PULV. IS 3800 M LB STEAM/HR BASED ON 59 GRIND

10,800 BTU COAL AT 71 % THRU 200 U.S.S. SIEVE

FOR 126 M LB COAL/PULV.-HR AT 70 % THRU 200 U.S.S. SIEVE MIN. GRIND

159 MAXIMUM SURFACE MOISTURE IS 10 % REQUIRING 540 F AIR

STEAM TEMP. CONTROL — MAIN STEAM: SPRAY ATTEMPERATOR

REHEAT STEAM: SPRAY ATTEMPERATOR & EXCESS AIR

UNIT CONSTRUCTION FEATURES — BALANCED DRAFT

MEMBRANE WALL

CASING TYPE ROOF SEALS

INDOOR

REVISIONS — NO.	DESCRIPTION	BY	DATE
	UNIT #2		

APPENDIX B

NO_x CONTROL DATA FROM FOSTER WHEELER ENERGY CORPORATION

All four major boiler manufacturers were invited to submit process data to aid in the assessment of NO_x control technology. For those who did respond, their replies are provided here and in Appendix A.

The information presented in this appendix was graciously supplied by the Foster Wheeler Energy Corporation of Livingston, New Jersey to aid in the NO_x control assessment. It is reproduced here in its entirety.

FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE · LIVINGSTON, NEW JERSEY 07039 · PHONE 201-533-1100

ADDRESS REPLY TO:
100 Pine Street, Suite 1795, San Francisco, California 94111
Telephone 415 - 421-6042 TWX: 910-372-7308

November 6, 1978

Acurex Corporation
485 Clyde Avenue
Mountain View, California 94042

Attention Dr. K. Lim

Subject: Final Report for NO_x Environmental Assessment Program
F.W.E.C. Contract #2-43-3245
Acurex Reference JC68383A

Gentlemen:

Attached please find three (3) copies of the subject report entitled, "Effectiveness of NO_x Emission Controls on Utility Steam Generators." This report may be provided to EPA, by Acurex, for publishing; any comments made by Acurex along with Foster Wheeler's replies, if any, are to be appended to the report.

Also attached are one set of drawings and data for each of four steam generators discussed in the report (labeled Units A, B, C and E). The drawings and data are to be considered confidential information and are being provided for Acurex's internal use only in performing analyses of the steam generators.

We trust this information is in compliance with your requests. Please advise us if any clarification is required.

Very truly yours,

FOSTER WHEELER ENERGY CORPORATION

J. W. Keelty
District Manager
Equipment/Fired Heater Sales
San Francisco Office

JV:JWK:vo
Enc.
cc Mr. J. Vatsky, FWEC New Jersey

CABLE ADDRESS: REWOP LIVINGSTONNEWJERSEY

FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE · LIVINGSTON, NEW JERSEY 07039 · PHONE 201-533-1100

EFFECTIVENESS OF NO_x EMISSION CONTROLS ON UTILITY STEAM GENERATORS

Prepared for

Acurex Corporation
Mountain View, California

Acurex Contract No. JC68383A
FWEC Contract No. 2-43-3245

FWEC Project Manager: J. Vatsky

CABLE ADDRESS: REWOP LIVINGSTONNEWJERSEY

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1.0 INTRODUCTION

This report is presented by Foster Wheeler Energy Corporation in cooperation with the NO_x Environmental Assessment Program of the U.S. Environmental Protection Agency. Data contained herein were provided from Foster Wheeler's test data inventory and are representative of steam generators designed prior to and after the advent of the New Source Performance Standard.

The following information is provided:

(1) Emissions and operating data for two pre-NSPS coal-fired steam generators.

(2) Emissions and operating data for a coal-fired unit designed to meet the NSPS.

(3) Incremental costs for NO_x controls on a typical 500 MW steam generator; as compared to the cost of that unit without NO_x controls.

(4) Emissions and operating data for a pre-NSPS oil-fired steam generator that was subsequently retrofitted with NO_x emission controls after it was sold. Also, some of the costs associated with the retrofit are supplied.

2.0 NO_x EMISSIONS: FORMATION AND METHODS OF CONTROL

A short review of the current view of NO_x emissions is presented in order that a better understanding of Foster Wheeler's control philosophy will be obtained.

2.1 NO_x Formation

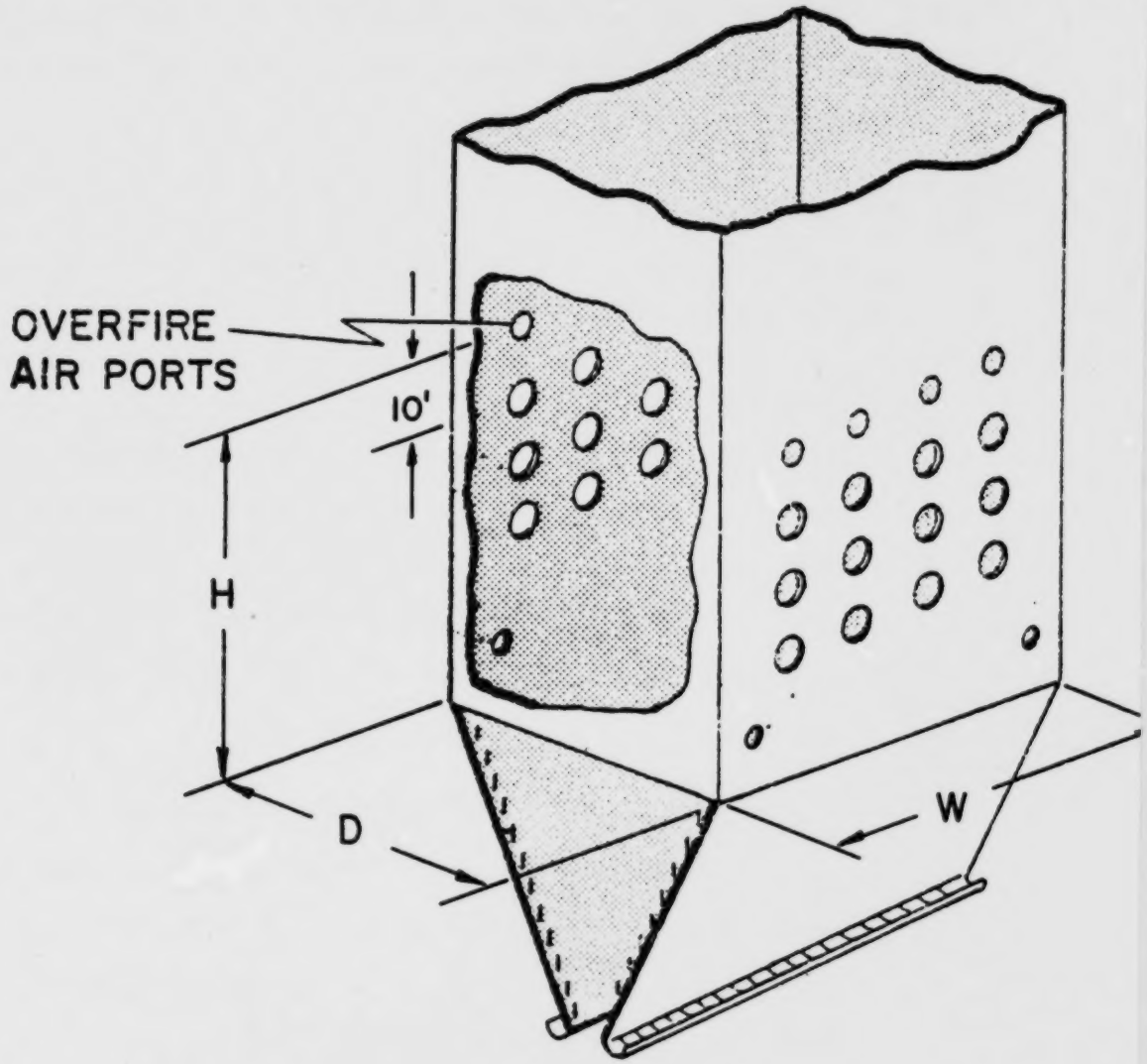
It is generally agreed that the total NO_x emission from a coal-fired boiler has three components:

A. Thermal NO_x

This component is formed from the high temperature fixation of atmospheric nitrogen. Thermal NO_x varies exponentially with flame temperature and is thus dependent on available cooling surface. However, since it generally accounts for the smallest of the NO_x components, measures to reduce flame temperature have only a moderate effect on total NO_x emission.

Boiler design affects the NO_x emission in that burner zone cooling surface influences the amount of thermal NO_x formed. Thus, for a given firing system and fuel, as unit size decreases NO_x emissions increase. The criterion used to quantify this effect is the Burner Zone Liberation Rate, which is defined as:

The net sensible heat input to the burner flame basket divided by the effective projected surface. The burner flame basket is the six-sided box started at the hopper knuckle and extending ten feet above the top row of burners, including all cooling surfaces in that volume. Figure 2.1 illustrates the flame basket region for a



FLAME BASKET OF TYPICAL LARGE BOILER BURNER ZONE SURFACE DEFINED BY H, D AND W.

FIGURE 2 – 1

typical boiler. Figure 2.2 demonstrates the variation of total NO_x with Burner Zone Liberation Rate. It is a composite of full load test data from front-wall fired units all utilizing similar high turbulence burners. The NO_x emission obtained from the curve represents that which would be generated in a unit, at full load, having the specified Q/BZS. There are a set of curves which are parametric in fuel nitrogen content per million Btu.

B. Volatile-Fraction Fuel NO_x

This component of the total emission is formed from that portion of the fuel-bound nitrogen which is contained in the volatile fraction of the fuel. It is generated in the near-throat region of the flame (approximately one to two throat diameters into the furnace). Figure 2.2 also shows the estimated fraction which is volatile fuel NO_x; generally at least 50%.

C. Char-Fraction Fuel NO_x

This component of the total NO_x emission is formed from the fuel nitrogen contained in the char and is generated in the later portion of the flame as the char is consumed. As much as 25% of the total emission may originate in the char.

A variable which has a major impact on NO_x emissions is fuel composition quality. The specific parameters of interest are percent fuel nitrogen content (% N_2) and higher heating value (HHV, Btu/lb) on an as-received basis. These parameters determine the total quantity of fuel-bound nitrogen being supplied to the burners. It can be expressed as lb $NO_2/10^6$ Btu of heat input (NO_2/Q).

UNCONTROLLED NO_x EMISSIONS
SINGLEWALL - FIRED UNITS

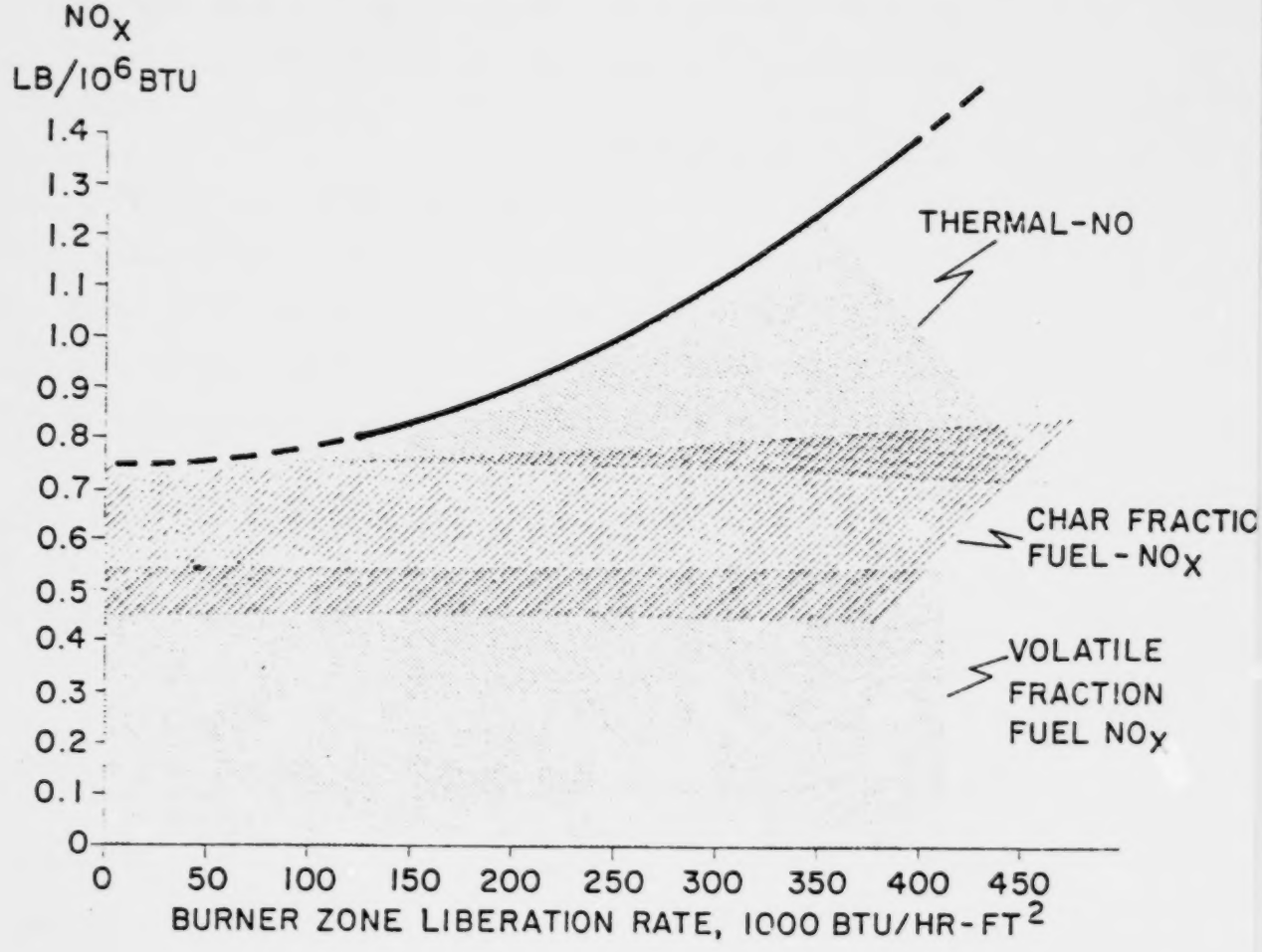


FIGURE 2 – 2

A coal with high nitrogen content and low heating value will have a high NO_x emission, most of which will be from fuel-bound nitrogen. Thus measures which affect thermal NO_x only (such as flue gas recirculation and additional cooling surface) will have a correspondingly smaller influence on total NO_x emission.

Since the total NO_x emission contains three components, each of which has a separate origin, different NO_x control techniques will affect each component differently. Some control methods will reduce all three components while others may reduce only one.

2.2 Methods of Control

The New Source Performance Standards have had a major impact on the design of steam generating equipment. Many units sold between 1971 and 1978 were designed to burn low sulfur coal as a means of meeting the sulfur emission regulation of the NSPS. Generally, the physical size of these units was increased to accommodate a wider range of slagging and fouling characteristics of these coals. The primary means of NO_x reduction has been combustion modification, but size increase is also necessary to provide the additional cooling surface required to accommodate low NO_x combustion.

A. Reduced Burner Zone Liberation Rate

The increase in unit size caused in part by the NSPS SO_2 and NO_x regulations provides a lowering of the Burner Zone Liberation Rate thereby decreasing the thermal NO_x component of the total NO_x emission. Thus, the uncontrolled NO_x emission (that is with no combustion modifications) is reduced.

Increased furnace size, providing greater burner basket cooling surface, is advantageous when using low emission burners or substoichiometric

levels of staged combustion. When the lower furnace becomes reducing the ash softening temperatures decrease thereby promoting the formation of slag. The effect of atmosphere condition on ash characteristics is illustrated in Figure 2.3. In general, the lower flame temperatures provided by low Burner Zone Liberation Rates will decrease ash temperature thereby reducing the potential for slag formation. Also, the abundant cooling surface increases total absorption which results in lower gas temperatures throughout the furnace, thus further reducing slag potential.

Foster Wheeler uses a combination of techniques which minimize the need for larger furnaces, beyond that required by coal quality and low NO_x combustion. These are discussed in detail in the following section.

B. Effect of Staged Combustion on NO_x

In general, the most effective means of reducing all three NO_x components, simultaneously, is staged combustion. Reducing air to the burners will decrease thermal and volatile-fraction fuel NO_x by creating a local reducing atmosphere in the near-throat burner region. Thus the two NO_x components, which together account for approximately 75% of the emission, are affected immediately.

Char-fraction fuel NO_x will also be decreased since most of the char will burn out in an oxygen deficient region; oxygen combines preferentially with carbon in a reducing atmosphere. In order to maintain low values of carbon monoxide and unburned carbon in the flue gas it is imperative that proper mixing between the lower

46 1510

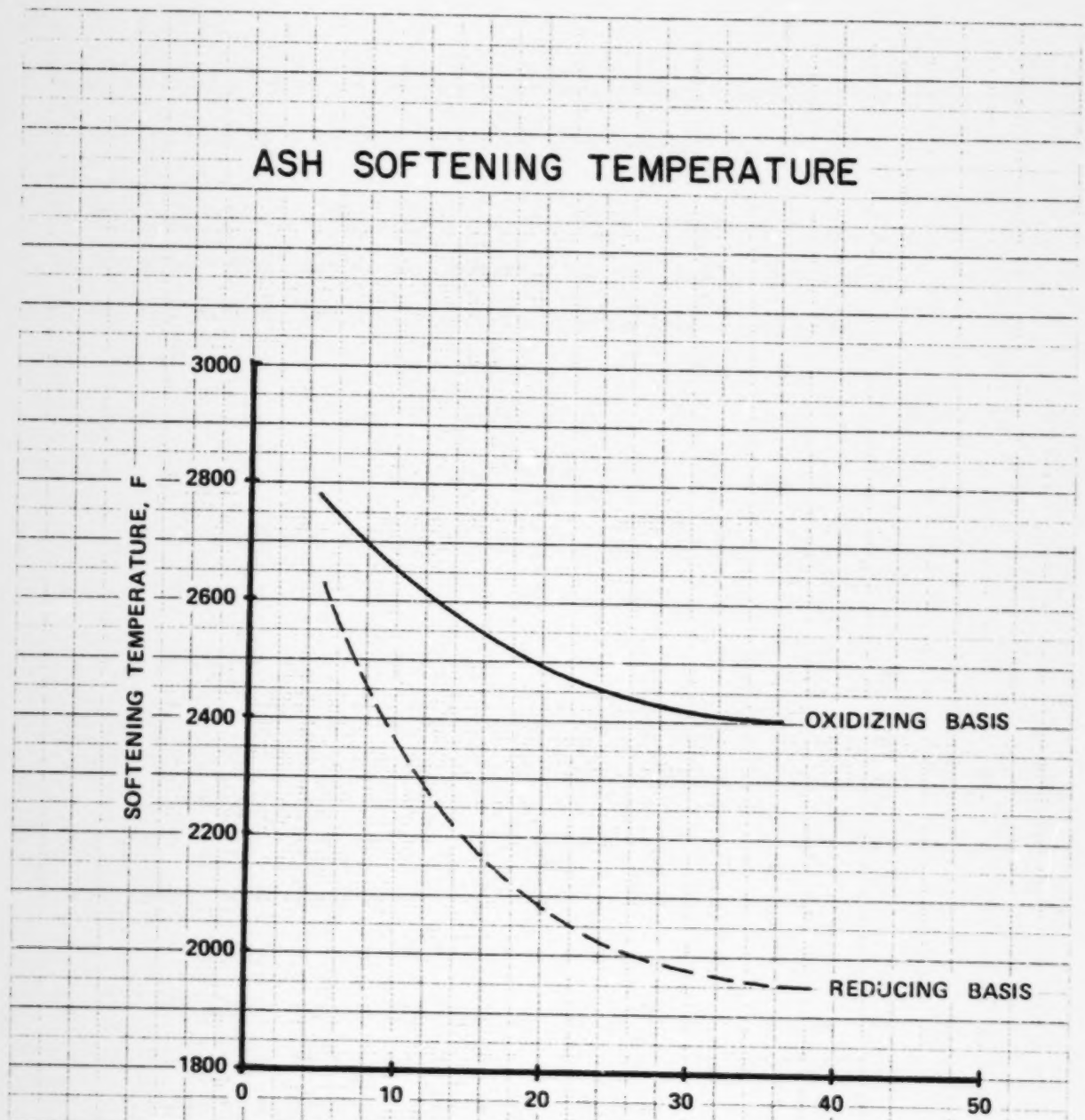


FIGURE 2 – 3

furnace gases and the overfire airport air flow be maintained; also, sufficient residence time below the convection pass is required.

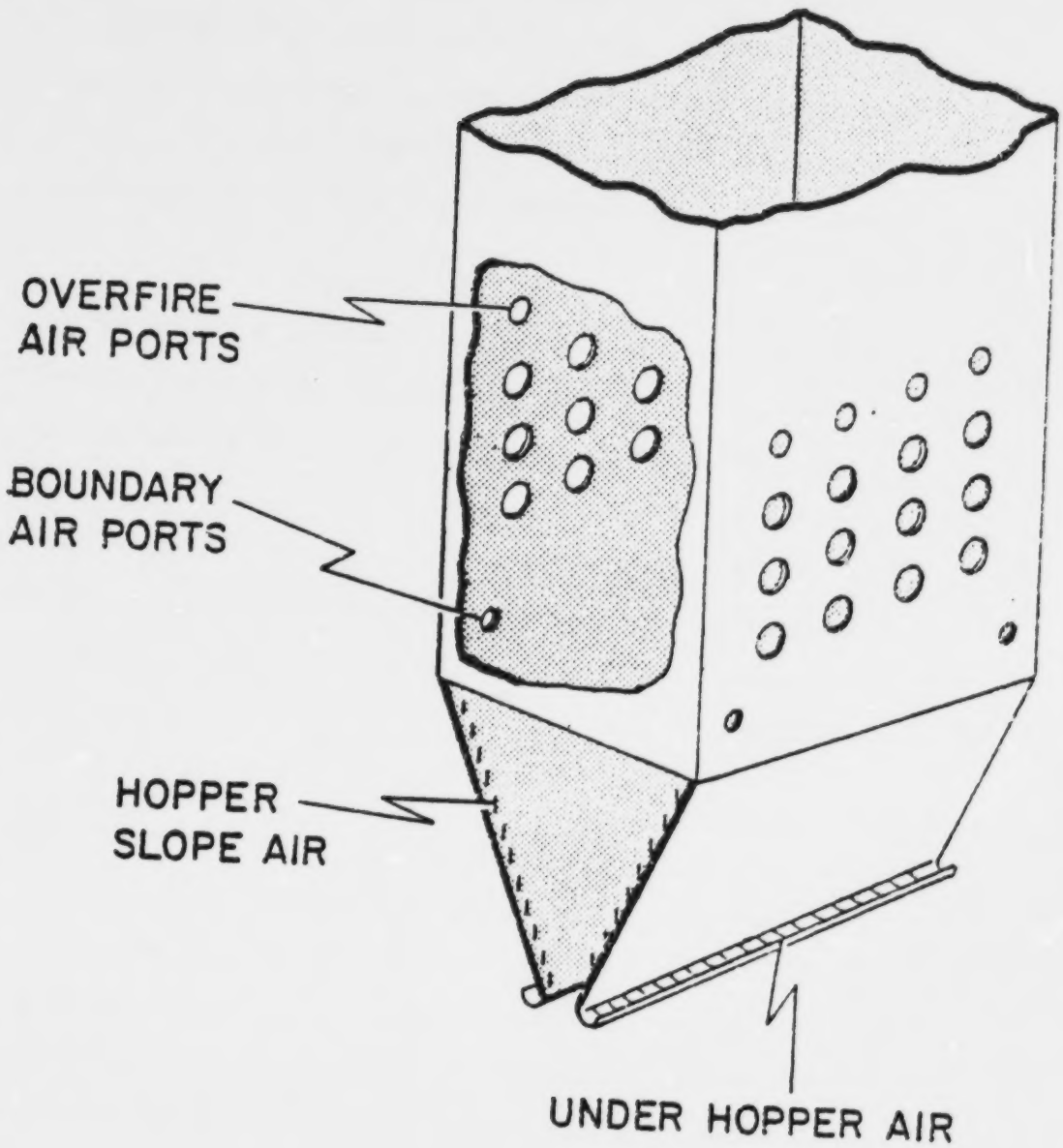
Although staged combustion is a highly effective means of NO_x control it also has the potential for causing severe problems. With many coals, particularly those with high sulfur, iron and alkali contents, slagging and waterwall tube wastage can be major problems. These are most likely to occur when hot ash particles approach the furnace walls in a reducing atmosphere.

Foster Wheeler utilizes staged combustion for NO_x control but with two considerations for minimizing the slagging and wastage potential:

(1) The minimum burner stoichiometry recommended for continuous operation is 96% of theoretical air.

(2) Boundary Air is used to provide an oxidizing atmosphere along the waterwalls in the hopper and burner zone. This technique, which is illustrated in Figure 2.4, consists of air entry slots located in the hopper throat and along the hopper slopes and ports located on the burner walls. It has been shown to be an effective means of controlling slag in numerous cases.

Staged combustion of coal, at burner stoichiometric levels below the minimum suggested above, is possible from a combustion stability viewpoint. Indeed, there are some low sulfur coals with good slagging characteristics which would not be expected to cause



BOUNDARY AIR CONCEPT

FIGURE 2 – 4

wastage problems; although this possibility has yet to be demonstrated in the field. However, Foster Wheeler would not recommend such low levels of sub-stoichiometric firing with most coals. Boundary Air, which works well when the burner zone is operated approximately at or above the stoichiometric level, would be ineffective at low stoichiometric levels with high slagging-potential coals.

Staged firing is thus limited in its practical applicability due to the effect on unit availability (slagging) and reliability (tube wastage). Certainly this technique would not be recommended for most older, pre-NSPS, coal fired units where the Burner Zone Liberation Rate would be too high to accommodate staged combustion for continuous operation. However, this technique may be considered on some older units where furnace sizing and coal characteristics are acceptable.

C. Effect of Burner Design

The actual fraction of each NO_x component, formed in a given unit, depends primarily on unit design, burner design and coal characteristics; the relative emissions can thus vary from unit to unit. However, since volatile-fraction fuel NO_x is formed in the early part of the flame and comprises the major part of the emission, burner design will have a drastic effect on NO_x emissions. Burner Zone Liberation Rate will have an important but secondary influence on the NO_x emission for coal or high nitrogen-content oil.

The Foster Wheeler Intervane Burner, shown in Figure 2.5, was used for many years prior to the advent of the NSPS. This burner was designed for high combustion efficiency in the physically small (high Burner Zone Liberation Rate) pre-NSPS boilers. As such it is a high intensity, high turbulence device which was very successful in achieving the purpose for which it was designed. However, its highly turbulent nature results in relatively high NO_x emissions. In order to permit staged combustion to be used with a wide range of coals, as the primary means of NO_x control on earlier NSPS boilers (those sold between 1971 and 1976), without resorting to burner stoichiometries below 96% it was necessary to modify the Intervane Burner. Initial modifications permitted the single register design to be retained while geometrical relationships were changed to provide reduced turbulent mixing in the early part of the flame. This Reduced Turbulence Burner, which is similar to that shown in Figure 2.5, provides NO_x levels 15-20% below historical levels for Foster Wheeler Intervane Burners.

In order to provide greater flexibility of operation, and further assurance that the NO_x emission regulation of 0.7 lb $NO_2/10^6$ Btu can be achieved with a minimum of overfire air, Foster Wheeler has developed a dual register low NO_x coal burner. This design is shown in Figure 2.6. NO_x reductions of 40-50% have been obtained with this burner when retrofitted to older steam generators. Functionally, the low NOx burner consists of the following components:

FW MULTI FUEL BURNER

INTERVANE BURNER
(PRE - NSPS DESIGN)

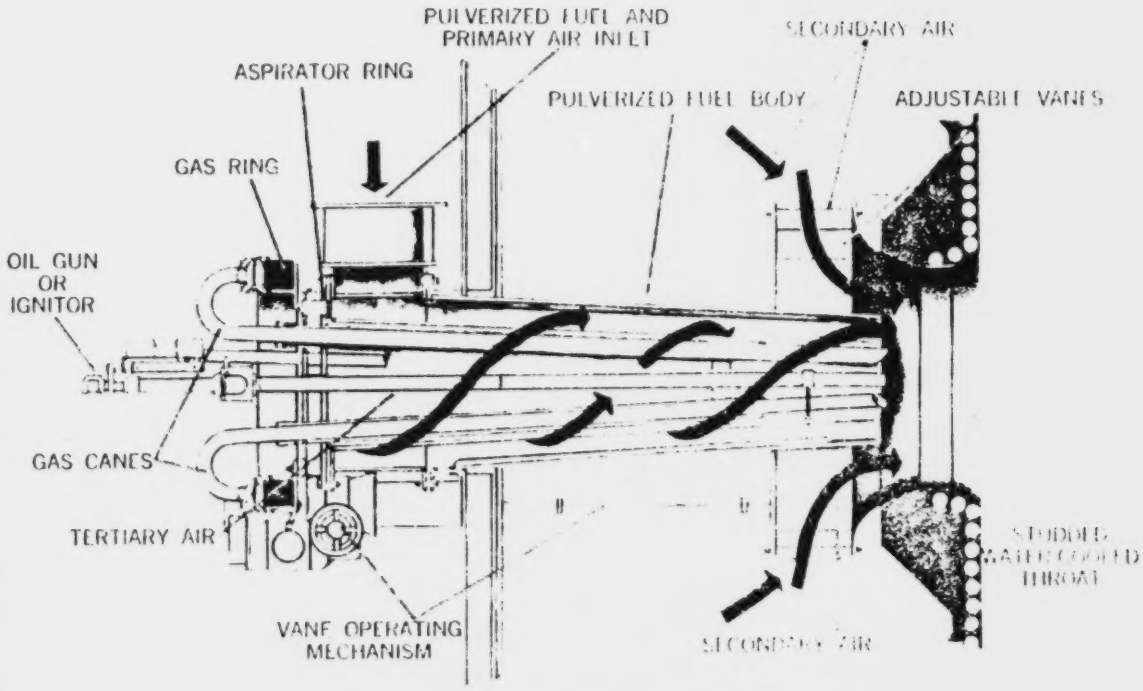


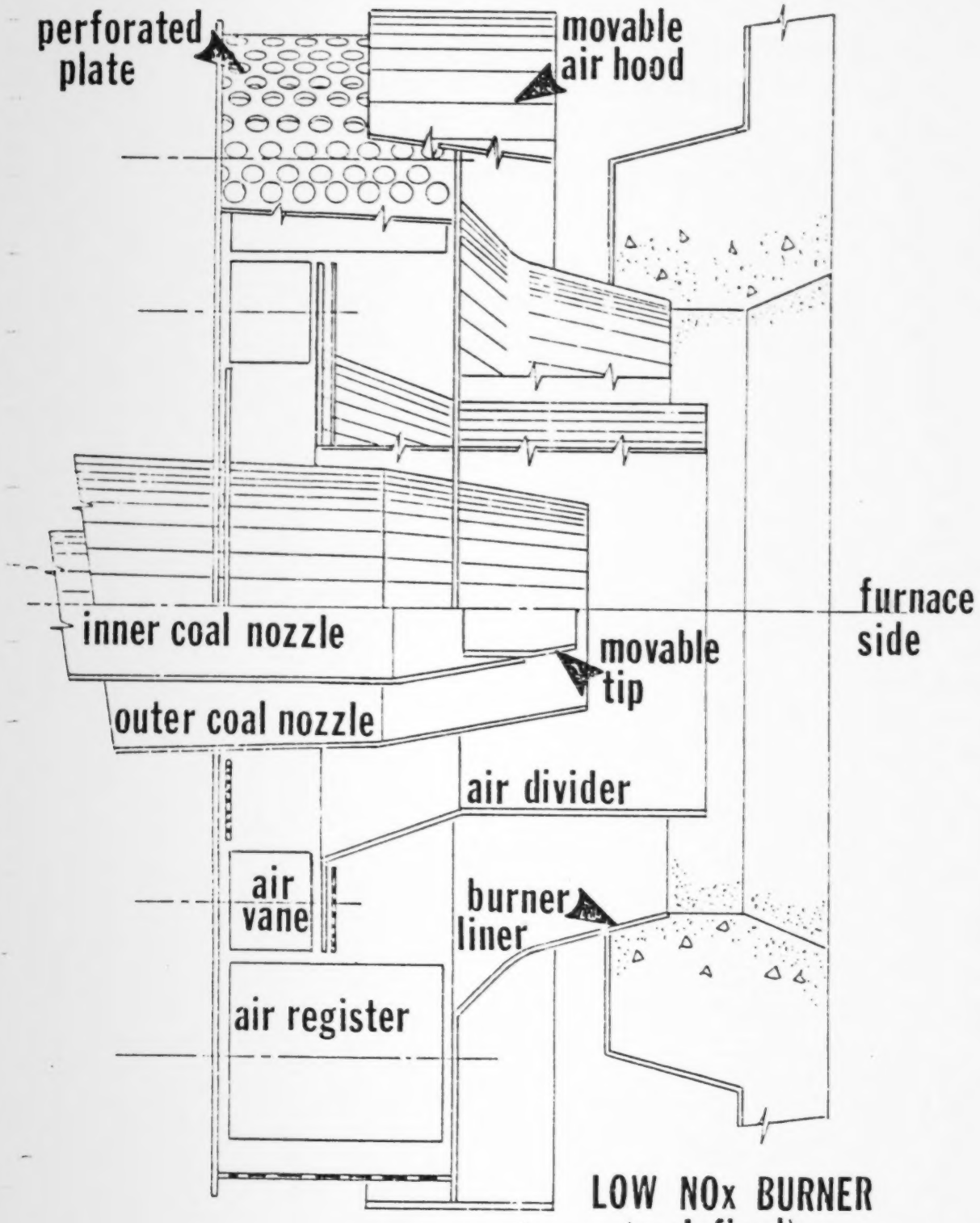
FIGURE 2 – 5

- Two registers: to provide independent control of the secondary air swirl in each of the two secondary air annulii. The rate of mixing between secondary air and the primary air/coal stream can therefore, be controlled.

- Annular coal nozzle: with an axially movable inner sleeve to provide a method of optimizing the velocity of the primary air/coal stream, at constant air flow.

- Perforated plate air hood and movable sleeve: Pressure drop across the perforated plate is measured to provide an index of relative air flow to the burners; the movable sleeve permits balancing of the secondary air between the burners. Thus, burner stoichiometry can be more closely controlled than has been historically possible.

LOW NO_x DUAL REGISTER COAL BURNER



LOW NOx BURNER
(coal fired)

FIGURE 2 – 6

3.0 PRACTICAL LIMITATIONS ON LOW NO_x FIRING

It has been demonstrated that large reductions in NO_x emissions can be attained by various types of combustion modifications; including staged combustion and burner redesign. The existing NSPS has been attained on new units using overfire airports only and, under specific conditions which are not commercially acceptable, on older unmodified units. Also, the limit has been attained on older units retrofitted with a low NO_x burner.

Although very low levels of NO_x have not yet been demonstrated on operating steam generators, more radical combustion modifications than those already demonstrated do appear to have the potential to provide additional reductions. Certainly, staged combustion, at burner stoichiometries well below 100% theoretical air, has that capability. Second and third generation low NO_x burners may also demonstrate such ability.

However, there are other factors of major importance, which strongly affect boiler performance, that can limit the applicability of these techniques. The foremost among these are:

- tube wastage which can affect unit life and reliability
- increased slagging which can affect unit availability
- burner stability can affect unit integrity

Tube wastage and slagging have been two of Foster Wheeler's greatest concerns in designing steam generators to meet the NSPS. When a boiler is operated in a manner which produces a reducing (oxygen deficient) atmosphere along a water-wall, and the fuel and ash properties are such as to promote slag formation, severe tube wastage can result. An example of this is shown in Figure 3.1. This is a cross-section of a sidewall tube that had been subjected to a reducing

EXAMPLE OF FIRESIDE TUBE WASTAGE

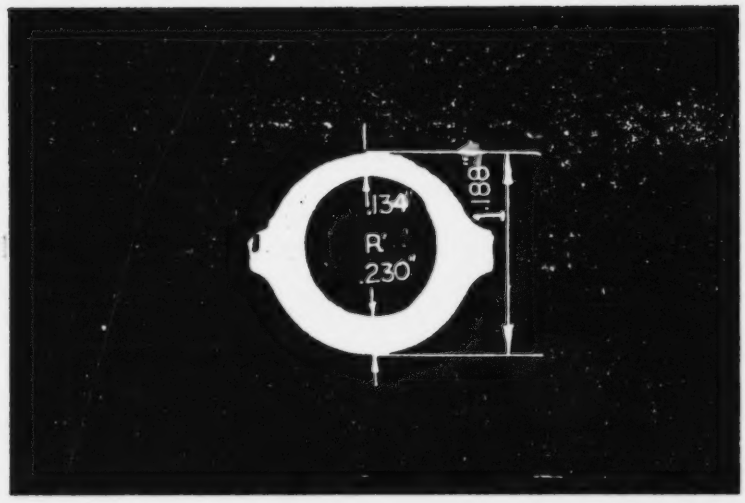


FIGURE 3 -- 1

atmosphere for approximately 30 months. A high-sulfur ($\geq$3.0 percent), high iron ($Fe_2O_3 \geq 20$ percent) bituminous coal with a low reducing ash fluid temperature was used.

The unit involved was designed prior to the advent of the NSPS and had been operating with 20-25 percent excess air at the burners. Poor air distribution on this unit result in side wall reducing atmosphere that is essentially the same as that which occurs with substoichiometric burner operation, as with overfire air ports. Other pre-NSPS units firing similar coal do not have a tube wastage problem; this was an isolated case.

The sidewall reducing atmosphere has since been eliminated by redistributing the windbox air flow and adding sidewall slots to permit air entry to the furnace. This has significantly alleviated the tube wastage problem thereby confirming that there is a strong link between this condition and oxygen level along the wall. It must also be noted that, although the wastage problem on this unit has been solved, this particular fuel, which is a troublesome one, has not yet been used in an NSPS steam generator with overfire air ports.

The reason for noting this particular example is to graphically demonstrate the rapidity with which tube wastage can occur, when the necessary conditions exist along the wall. Foster Wheeler believes that this problem could become endemic if the NSPS NO_x limit was lowered sufficiently to require staged firing at burner stoichiometric levels below those now deemed acceptable. It must also be noted that it has not yet been demonstrated that there are no adverse long-term effects with the methods used to attain the current

NSPS; either low-NO_x burners or overfire airports. The Environmental Protection Agency also recognizes this problem and is sponsoring a long-term program to quantify the effects of low NO_x combustion techniques on tube wastage and unit operability. Foster Wheeler, as the first boiler manufacturer to support this program, has been cooperating with EPA for over two years in an active wastage test program.

Historically coal burners have been designed to provide high-intensity, stable flames with turn down ratios to at least 40% of rated capacity. Low NO_x burners, in contrast, utilize aerodynamics to control mixing rates between fuel and combustion air. An acceptable low NO_x burner must permit the steam generator to be operated over the same range of conditions as the historical high turbulence burners. Flame stability and combustion efficiency must be maintained over the same historical turndown ratio. Those low NO_x coal burners which have been successfully demonstrated on utility steam generators have maintained these criteria while producing NO_x emissions 50% below historical levels.

More advanced low NO_x burners, which may yield NO_x emissions significantly lower than those already attained, have not yet been demonstrated on utility steam generators. The ability of more advanced low NO_x designs to maintain their low emission character with stable flames will have to be shown over wide ranges of throat velocity and fuel inputs.

Flame stability is critical to safe operation of the boiler. There is no cost-benefit tradeoff which will permit degradation of this operating parameter.

4.0 STEAM GENERATOR TEST DATA

Foster Wheeler has tested numerous pre-NSPS coal-fired steam generators in order to characterize the parameters which control the formation of NO_x; the effect of various combustion modifications has also been determined. The primary parameters of interest are the following:

1. Unit Design
   - (a) Opposed-fired vs. single-wall fired
   - (b) Available cooling surface compared to heat input (Burner Zone Liberation Rate)

2. Fuel Qualities
   - (a) Heating value
   - (b) Nitrogen content
   - (c) Slagging properties
   - (d) Sulfur content

3. Operational Parameters
   - (a) Load
   - (b) Excess air
   - (c) Burner out of service operation (staged combustion)

In addition to the field test program Foster Wheeler also began a program to develop a new coal burner which would be inherently low in NO_x production. The resultant burner was successfully demonstrated in Japan by Foster Wheeler's licensee, Ishikawajima-Harima Heavy Industries Ltd. (IHI), on three older utility boilers. This Dual Register Burner, described earlier, has been offered commercially since late 1976. However, to date there are no NSPS units in operation using this burner although new units have been sold with this design.

Consequently the data for the NSPS units presented here were obtained with the Intervane Burner and overfire air ports. This combination has been successful in permitting the current emission regulation of 0.7 lb $NO_2/10^6$ Btu to be achieved with no apparent detrimental impacts to boiler ingetrity or operation.

4.1 PRE-NSPS COAL-FIRED UNITS

Data from two pre-NSPS steam generators are presented, they are representative of the two utility boiler types designed by Foster Wheeler: single-wall fired and opposed-fired. The units chosen from the test data inventory are typical of those sold just prior to the advent of the NSPS regulations. As such they were designed with the high turbulence Intervane Burner and have relatively high Burner Zone Liberation Rates to maximize efficiency. NO_x emissions are, therefore, high.

4.1.1 Opposed-Fired Steam Generator: Unit A

Figure 4.1 shows a side elevation view of the opposed-fired unit which was tested for NO_x emissions. The unit utilizes 24 Intervane Burners, 12 per firing wall in a 4 wide x 3 high arrangement, supplied by six Foster Wheeler medium speed MB-22 pulverizers. It is a natural circulation reheat type steam generator with a capacity of 3,620,000 lb. per hour superheated steam at 2485 psig and 1000F at the outlet and 3,206,500 lb/hr reheated steam at 570 psig and 1000F at the outlet.

Table 4-1 lists the unit design parameters and performance fuel.

Emissions tests were performed to characterize the effect on NO_x production of:

- Unit load
- Excess air
- Staged combustion

UNIT A

FOSTER WHEELER

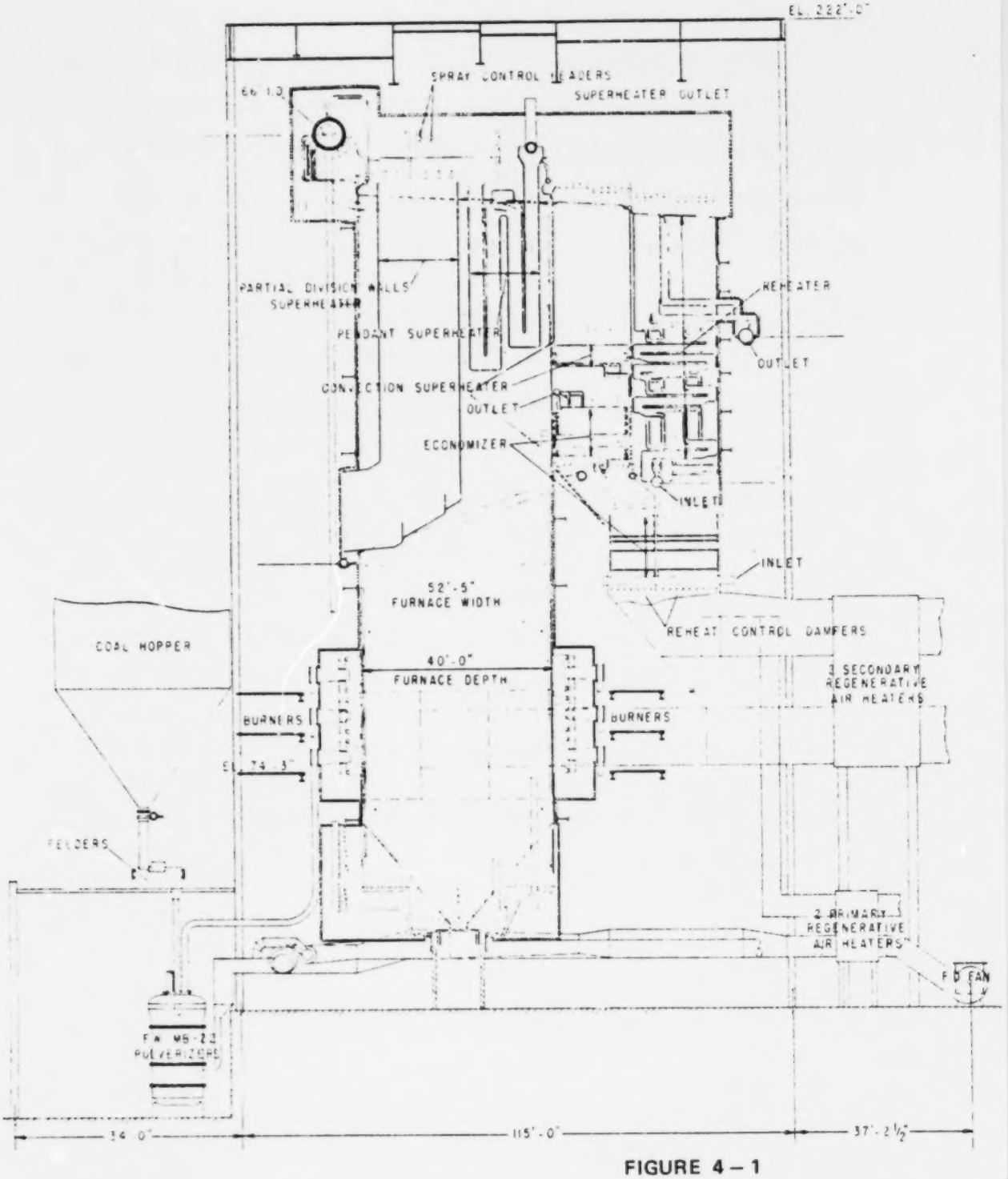


FIGURE 4 – 1

TABLE 4-1. UNIT A DESIGN DATA AND PERFORMANCE FUEL

Convection surface boiler	3,800 sq. ft.
Walls in furnace	26,044 sq. ft.
Radiant superheater	35,223 sq. ft.
Convection superheater incl. HRA walls	34,425 sq. ft.
Reheater	98,135 sq. ft.
Economizer	153,600 sq. ft.
Air heater primary	44,200 sq. ft.
Air heater secondary	485,800 sq. ft.
Total furnace volume	291,100 cu. ft.
Total furnace surface	62,763 sq. ft.
Firing equipment	Six MB 22 Pulverizers
Superheat control by	Spray
Performance based on fuel specified below:	
Kind	Bituminous Coal
Grindability	55
Size	1-1/2"
Max. moisture	8.5%*
Prox. Analysis Percent	
Moisture	8.5
Volatile matter	38.0
Fixed carbon	45.0
Ash	8.5
Softg. temp. of ash	2000F
Ultimate Analysis	
Fuel	Bituminous Coal
Percent by	Weight
Ash	8.5
S	3.7
H_2	4.7
C	66.6
H_2O	8.5
N_2	1.2
O_2	6.8
Btu-lb as fired	12,000

*Surface moisture 5%

Overfire air port operation (staged combustion) was simulated by removing the top opposed burner rows from service. Since it was necessary to remove one-third of the mill capacity from operation during the staged combustion tests all of these tests were performed at 70% of Maximum Continuous Rating (MCR); other, higher load normal firing, tests were performed with all burners in service.

Figure 4.2 is a composite plot of the measured data using a mapping procedure which permits the parametric relationships between NO_x, load, excess air and degree of staging to be immediately apparent. Figure 4.3 is a composite mapped plot of the measured carbon monoxide (CO) data.

Table 4-2 is a listing of all relevant measured parameters, including fuel ultimate analysis for each test.

Evaluation of the test data indicates that NO_x emissions are sensitive to the operating parameters being tested. In order of importance:

(a) Burner Excess Air (Degree of Staging):

Utilizing overfire air ports, in this case by simulation, to reduce the burner air while maintaining unit excess air constant provides a significant reduction in NO_x emissions. At 75% MCR a NO_x reduction of 40% was obtained by removing the top eight burners from service and opening the registers to the 37.5% position, at 20% excess air. Burner stoichiometry was lowered

KEUFFEL & ESSER CO.

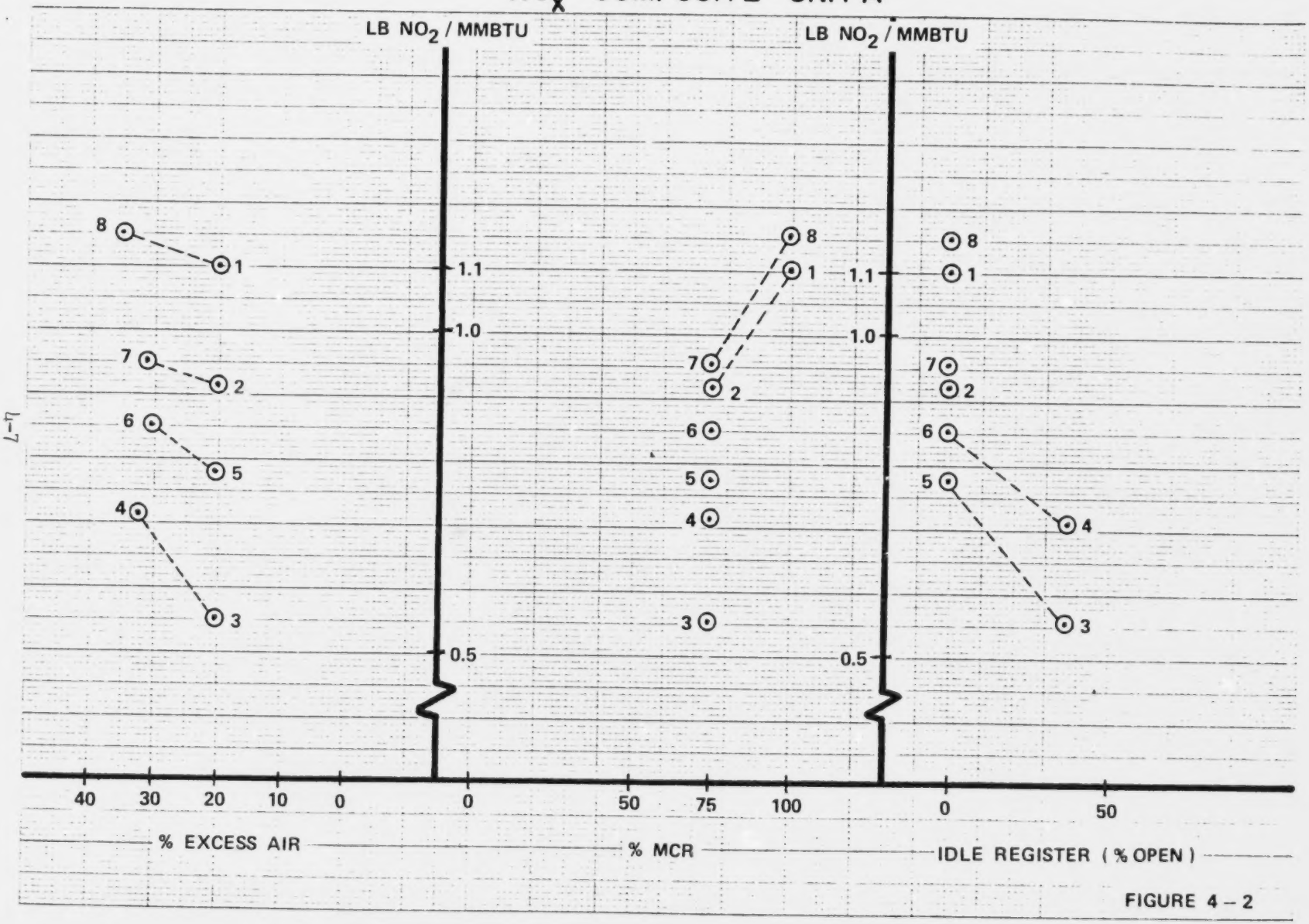


FIGURE 4 – 2

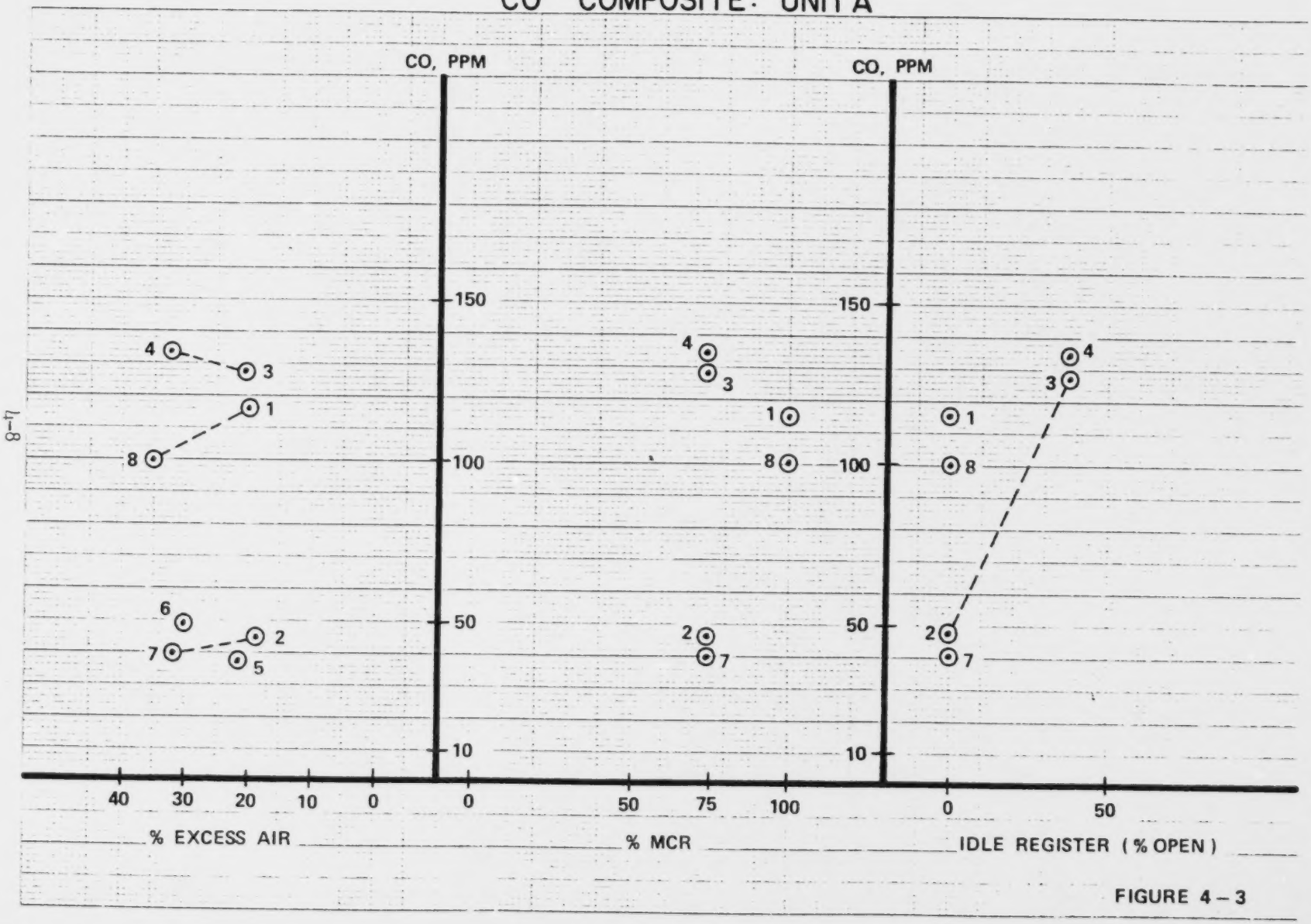

CO COMPOSITE: UNIT A
CO, PPM
150
100
50
10
4
3
1
8
6
7
2
5
40
30
20
10
0
% EXCESS AIR
0
50
75
100
% MCR
CO, PPM
150
100
50
10
4
3
1
8
2
7
0
50
IDLE REGISTER (% OPEN)

FIGURE 4 – 3

TABLE 4-2. UNIT A TEST DATA

TEST NO.	I	II	III	IV
Steam . . M lb/hr	3333	2550	2600	2550
Pressure superheater outlet . . psi	2380	2397	2275	2300
Temperature steam superheater outlet . F	992	1001	980	985
Pressure Boiler Drum . . psi	2500	2547	2488	2450
Reheat steam . . M lb/hr	3010	2300	2350	2300
Temperature steam entering reheater . . F	637	619	603	550
Temperature steam leaving reheater . . F	973	990	955	980
Pressure steam entering reheater . . psi	555	440	440	440
Pressure steam leaving reheater . . psi	524	410	410	410
Temp. feed entering unit . . F	476	457	461	463
Temp. feed leaving econ. . . F	636	607	617	629
Temp. air entering unit avg. pri & sec . F	154	166	167	166
Temp. air leaving air heater avg. pri & sec F	475	492	488	492
Temp. gas leaving furnace (HVT) . . F	1960	1860	1860	1825
Temp. gas leaving boiler . . F	N.A.	N.A.	N.A.	N.A.
Temp. gas leaving economizer . . F	738	695	698	717
Temp. gas leaving air heater . . F	N.A.	N.A.	N.A.	N.A.
Ditto corrected for leakage avg. pri & sec F	292	286	286	291
Excess air leaving . . %	20	19.5	20.5	32.0
Wet gas entering air heater . . M lb/hr	4234	3294	3451	3652
Wet gas leaving air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air entering air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air leaving air heater . . M lb/hr	3905	3034	3175	3377
Pressure in furnace . . in. H_2O	N.A.	13.5	12.0	14.4
Air & gas loss total . . in. H_2O	N.A.	N.A.	N.A.	N.A.
Pressure loss Drum to Sho Hdr . . psi	120	150	213	150
Fuel burned . . M lb/hr	365	287	303	299
Liberation, total vol Btu/hr x cu ft.	14,915	11,734	11,803	11,741
Furn. cooling factor net Btu/hr x sq. ft.	69,155	54,402	54,726	54,436
Heat Losses				
Dry gas . . %	3.921	3.403	3.539	3.959
Hydrogen and moisture in fuel . . %	4.398	4.204	4.304	4.502
Moisture in air . . %	.094	.083	.086	.097
Unburned combustible . . %	.221	.155	.414	.403
Radiation . . %	.190	.250	.25	.25
Unaccounted for . . %	.50	.50	.50	.50
Total losses . . %	9.324	8.595	9.093	9.711
Efficiency . . %	90.676	91.405	90.907	90.289

TABLE 4-2. UNIT A TEST DATA

TEST NO.	V	VI	VII	VIII
Steam . . M lb/hr	2500	2600	2543	3327
Pressure superheater outlet . . psi	2370	2406	2370	2398
Temperature steam superheater outlet . . F	995	990	998	993
Pressure Boiler Drum . . psi	2522	2510	2522	2507
Reheat steam . . M lb/hr	2250	2350	2290	2940
Temperature steam entering reheater . . F	N.A.	N.A.	N.A.	N.A.
Temperature steam leaving reheater . . F	979	965	1000	991
Pressure steam entering reheater . . psi	430	440	440	549
Pressure steam leaving reheater . . psi	400	410	410	517
Temp. feed entering unit . . F	455	459	457	475
Temp. feed leaving econ. . . F	615	622	622	650
Temp. air entering unit ave. pri. & sec. F	166	157	160	147
Temp. air leaving air heater ave. pri. & sec.F	478	459	486	496
Temp. gas leaving furnace . . F	N.A.	N.A.	N.A.	N.A.
Temp. gas leaving boiler . . F	N.A.	N.A.	N.A.	N.A.
Temp. gas leaving economizer	692	698	713	745
Temp. gas leaving air heater	N.A.	N.A.	N.A.	N.A.
Ditto corrected for leakave ave. pri. & sec.F	277	270	287	292
Excess air leaving . . %	20.5	30.0	31.	35.
Wet gas entering air heater . . M lb/hr	3383	3476	3618	4843
Wet gas leaving air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air entering air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air leaving air heater . . M lb/hr	3115	3210	3356	4505
Pressure in furnace . . in. H_2O	12.2	14.4	15.3	N.A.
Air & gas loss total . . in. H_2O	N.A.	N.A.	N.A.	N.A.
Pressure loss Drum to Sho Hdr . . psi	152	104	152	109
Fuel burned . . M lb/hr	304	300	290	379
Liberation total vol. Btu/hr x cu ft.	11,529	11,880	11,816	14,865
Furn. cooling factor net Btu/hr x sq. ft.	53,470	55,102	54,805	68,997
Heat Losses				
Dry gas . . %	3.531	3.958	3.864	4.644
Hydrogen and moisture in fuel . . %	4.520	4.313	4.223	4.623
Moisture in . . %	.086	.095	.094	.112
Unburned combustible . . %	.258	.258	.155	.230
Radiation . . %	.260	.25	.250	.190
Unaccounted for . . %	.500	.500	.500	.500
Total losses . . %	9.155	9.374	9.086	10.299
Efficiency . . %	90.845	90.626	90.914	89.701

TABLE 4-2. UNIT A TEST DATA

TEST NO.	1	2	3	4	5	6	7	8
Prox. Analysis (%)								
Moisture	7.10	7.88	9.37	10.40	9.61	7.38	7.88	6.90
Volatile Matter	36.56	35.99	36.11	35.19	34.62	34.79	35.99	36.95
Fixed Carbon	46.66	46.80	45.70	46.68	44.13	46.57	46.80	45.44
Ash	9.68	9.33	8.82	7.73	11.64	11.29	9.33	10.72
Ult. Analysis (%) By Weight								
Ash	9.68	9.33	8.82	7.73	11.64	11.29	9.33	10.72
S	2.59	2.86	2.75	2.34	3.06	2.96	2.86	3.18
H_2	4.52	4.28	3.99	4.12	4.07	4.26	4.28	4.58
C	65.56	65.42	65.27	64.20	62.70	65.21	65.42	64.09
H_2O	7.10	7.88	9.37	10.40	9.61	7.38	7.88	6.90
N_2	1.42	1.26	1.35	1.30	1.22	1.30	1.26	1.31
O_2	9.13	8.97	8.45	9.91	7.70	7.60	8.97	9.22
Btu/lb (as fired)	11,879	11,878	11,347	11,414	11,030	11,540	11,878	11,418
Wet Flue Gas Analysis By Volume								
% CO_2	13.942	14.101	14.103	12.903	13.891	13.927	12.921	12.355
% H_2O	8.701	8.591	8.469	8.308	8.760	8.426	8.032	8.105
% SO_2	.207	.231	.224	.177	.255	.237	.212	.230
Gas Emission Data								
NO_x (ppm)	797	668	390	465	545	559	632	728
NO_2 (lb/10^6 Btu)	1.096	0.912	0.550	0.705	0.774	0.854	0.944	1.153
SO_2 (ppm)	2209	2503	2554	2360	2505	2338	2242	1908
CO (ppm)	115	44	128	133	38	48	40	100
Ash Fusion Temp. °F (Red./Oxid.)								
Initial Deform.	N.A.	1900/2310	N.A.	1920/2360	N.A.	N.A.	1900/2310	N.A.
Soft. Temp. Sph.	N.A.	1930/2380	N.A.	1960/2460	N.A.	N.A.	1930/2380	N.A.
Soft. Temp. Hem.	N.A.	1960/2420	N.A.	2000/2500	N.A.	N.A.	1960/2420	N.A.
Fluid Temp.	N.A.	2000/2500	N.A.	2250/2530	N.A.	N.A.	2000/2500	N.A.

from 120% to approximately 95%. The reduction rate varies from unit to unit depending on unit and burner design as well as coal characteristics.

(b) Unit Excess Air:

Total excess air has a moderate affect on NO_x emissions under normal firing, all burners in service, operation. However, with staged firing the sensitivity of NO_x emissions to excess air is increased significantly. This sensitivity is not due entirely to excess air. Under the conditions of these tests the burners were operating at maximum design heat liberation only during the staging tests; during all other tests they were well below maximum. This is demonstrated by the following table:

Load	Burners in Service	NO_x Change with X_S Air	Burner Liberation
3333 Mlb/hr	24	3.33×10^{-3} lb/10^6 Btu/%X_S Air	181×10^6 Btu/hr
2550 Mlb/hr	24	4.167×10^{-3} lb/10^6 Btu/%X_S Air	142×10^6 Btu/hr
2550 Mlb/hr	16	13.33×10^{-3} lb/10^6 Btu/%X_S Air	213×10^6 Btu/hr

Maximum Design Burner Liberation: 224×10^6 Btu/hr

The maximum sensitivity of NO_x emissions to excess air, on this unit, occurs at maximum burner liberation. Since the unit is designed for operation at 18% excess air, and the burner is optimized for that level, increases in excess air at maximum liberation will cause a significant increase in turbulence. This is due mainly to the burner throat velocity increasing beyond its optimum design value.

(c) Unit Load:

NO_x is generally expected to decrease with unit load, as is the case here. The reduction is due to decreasing the Burner Zone Liberation Rate as well as to reduced burner turbulence. The reduced turbulence decreases the formation rate of fuel NO_x while decreasing the lower furnace heat input reduces the formation of thermal NO_x.

(d) Unit Operability:

As shown in Table 4-2 there is no detrimental effect on combustion efficiency due to staging. At 75% load there is an increase in CO as idle registers are opened. The full load CO level of about 100 ppm is high for a unit of this type which should emit levels well below 50 ppm; the reduction in CO as the top burners are idled may indicate that one or more of those registers was maladjusted.

(e) Furnace Conditions:

When utilizing staged combustion a primary consideration is, as discussed earlier, the effect on slag formation of reducing atmospheres in the lower furnace. Consequently, during all tests furnace and flame conditions were closely observed. The following observations were made during the test sequence:

(1) Full Load Tests (all burners in service): Furnace conditions very good; bright and clear. Superheater clean with a slight accumulation of dry ash on the leading edge. Furnace walls good with dry ash on front wall and light sponge ash on middle section of rear wall.

(2) 75% MCR (all burners in service, 20% X_S Air): Spongy ash on front leading edges of finishing superheater; dry ash on walls. Fires bright and stable; eyebrows on some burners.

(3) 75% MCR (all burners in service; 35% X_S Air): All upper furnace walls clean; 2" ash on leading edges of pendant superheater. Burner basket rear wall is clean; ½" wet sponge ash on front wall; sidewalls ½" dry to wet sponge.

(4) 75% MCR (top burners out of service and registers closed; 20% X_S Air): (Burner Stoichiometry approximately 110%) Upper furnace walls clean; 2" ash on finishing superheater. Burner basket front wall clean, ½" wet sponge ash on side and rear walls. Hopper clean.

(5) 75% MCR (top burners out of service and registers 25% open; 20% X_S Air): (Burner stoichiometry approximately 100%) Slag conditions are the same as previous test but eyebrows on top row of burners are running.

(6) 75% MCR (top burners out and registers 37.5% open; 20% X_S Air): (Burner stoichiometry approximately 90-95%) Furnace walls have accumulation of dry ash; 2"-3" of sponge ash on leading edges of superheater tubes. Heavy eyebrows on many active burners; rear burners eyebrows more plastic than front but not running. Flames carrying high into furnace and superheater.

(7) 75% MCR (top burners out and registers 50% open; 20% X_S Air): (Burner stoichiometry approximately 80-85%)
Loss of flame definition, fires filling flame basket and carrying very high into pendant section. Upper furnace and pendant conditions the same as previous test. Plastic slag in mid-furnace, 1½" on burner walls and 1" on side walls. Burner zone front and side wall 1" wet sponge ash; rear wall 1½" plastic slag. Eyebrows on top burner row running excessively. Large slag logs on both right sidewall hopper slopes.

All of these tests were of short duration, yet it is clear that furnace and flame conditions would prohibit substoichiometric burner operation of this unit, with this fuel. Similar results have been obtained on other tests performed by Foster Wheeler on other pre-NSPS steam generators.

It should be noted that these staged combustion tests were all performed at 75% of unit maximum continuous rated load. Although those short tests with non-substoichiometric staged combustion (that is with burner stoichiometry greater than 100% but less than total unit air) were acceptable, it is unclear whether these conditions could be maintained continuously. Certainly a unit of this design and Burner Zone Liberation Rate would be unable to operate at full load under staged combustion conditions.

4.1.2 Front-Wall Fired Steam Generator: Unit B

Figure 4.4 shows the side elevation view of the single-wall fired unit. It contains 16 Intervane Burners, in a 4 x 4 matrix, on the front wall supplied by four Foster Wheeler MB-22 pulverizers. It is a natural circulation reheat type steam generator with a capacity of 2,320,000 lb. per hour superheated steam at 2625 psig and 1005°F at the outlet and 2,030,000 lb. per hour reheated steam at 560 psig and 1005°F at the outlet.

Table 4-3 lists the unit design parameters and performance fuel.

This unit was tested in the same manner as Unit A: overfire air was simulated by removing the top row of burners from service and opening their registers. NO_x emissions as functions of load and excess air were also investigated.

Figure 4.5 is the composite, mapped data showing the parametric relationships between NO_x, load, excess air and degree of staging. Table 4-4 is a listing of all relevant measured parameters.

Evaluation of the test data for this front-wall fired unit indicates that NO_x emissions are sensitive to the same operating parameters as the opposed-fired unit discussed previously. All trends are similar, although levels and rates of change are different. The following is a discussion of the individual parameter effects in the same order as previously:

UNIT B

FOSTER WHEELER

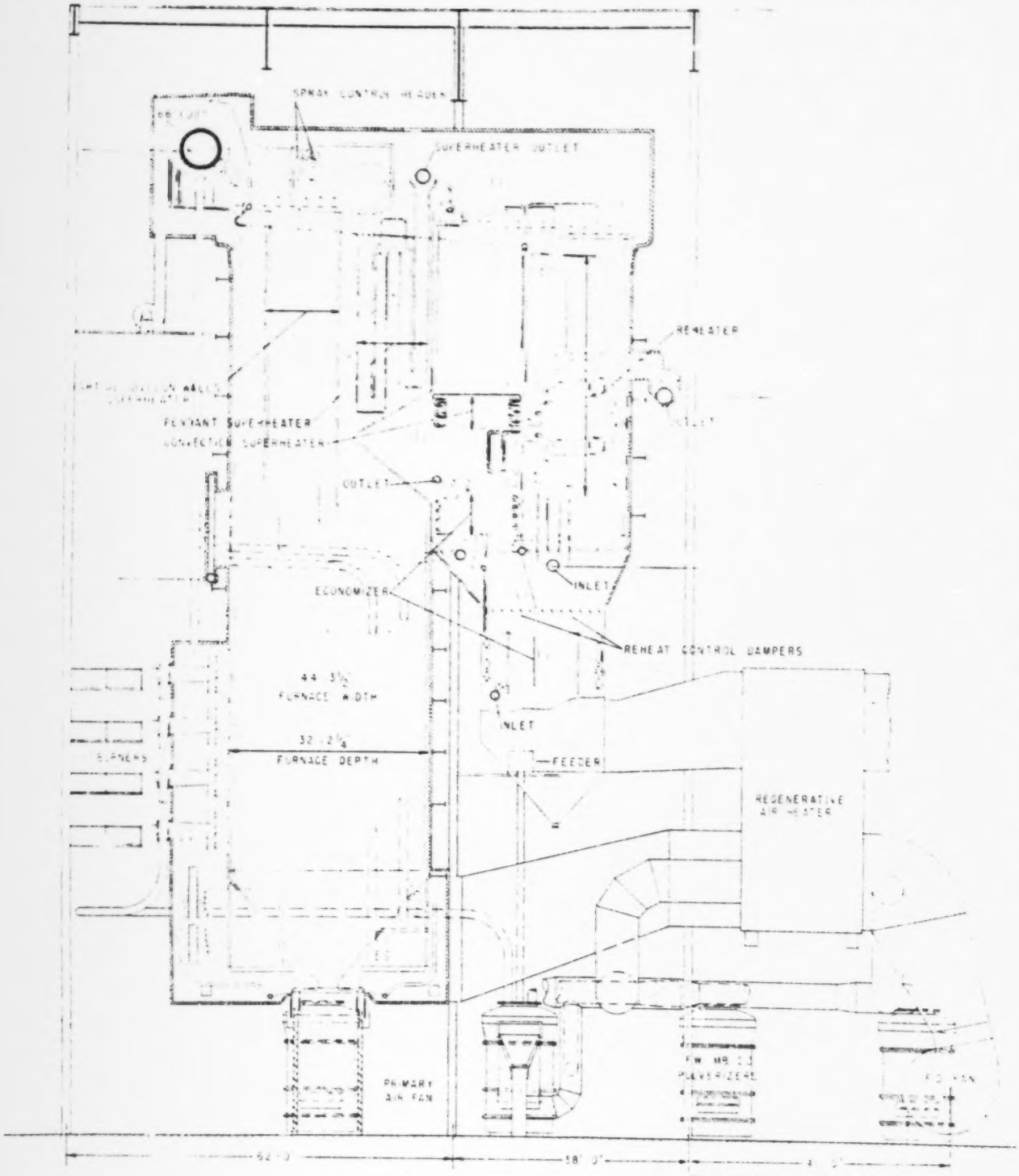


FIGURE 4 – 4

TABLE 4-3. UNIT B DESIGN DATA AND PERFORMANCE DATA

Walls in furnace	17,982 sq. ft.
Radiant superheater	25,380 sq. ft.
Convection superheater (A)	34,610 sq. ft.
Convection enclosure	2,843 sq. ft.
Reheater	73,961 sq. ft.
Economizer	99,000 sq. ft.
Air heater	454,400 sq. ft.
Total furnace volume	160,000 cu. ft.
Firing equipment	Four MB22 Mills

Performance based on fuel specified below:

Kind	Bituminum Coal
Grindability	50* Hardgrove
Size	1-1/4"
Max. moisture	13.1

Prox. analysis percent

Moisture	13.1
Volatile matter	35.6
Fixed carbon	43.6
Ash	7.7
Soft temp. of ash	2100 min.

Ultimate Analysis

Fuel	Bituminus Coal	H_2O	13.1
Percent by	Weight	N_2	1.2
Ash	7.7	O_2	12.5
S	1.2	Btu/lb	
H_2	4.7	as fired	10.662
C	59.6		

KEUFFEL & ESSER CO.

NO_x COMPOSITE: UNIT B

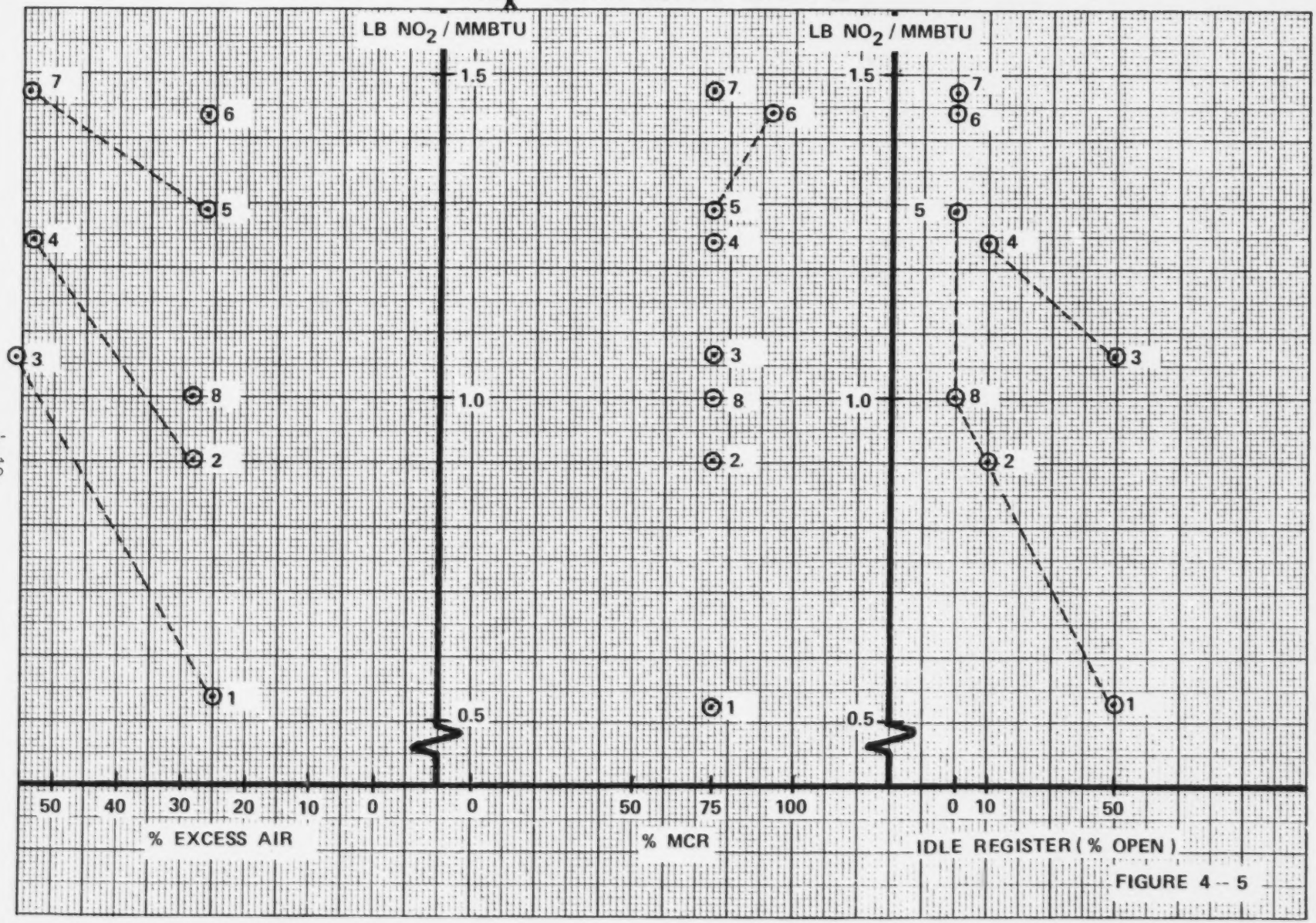


FIGURE 4 – 5

TABLE 4-4. UNIT B TEST DATA

TEST NO.	1	2	3	4	5	6	7	8
% MCR	75	75	75	75	75	93	75	75
% Excess Air	24.5	28.2	56.7	53.3	26.8	26.8	53.7	27.5
Steam (MLB/HR)	1800	1800	1800	1800	1800	2150	1745	1800
Fuel Burned (MLB/HR)	234	238	240	251	256	299	274	236
Air Leaving AH (MLB/HR)	2412	2526	3046	3186	2585	3020	3047	2491
Wet Gas Entering AH (MLB/HR)	2620	2737	3259	3408	2816	3289	3282	2700
Ultimate Analysis (%) By Weight								
Ash	11.38	11.38	11.38	11.38	10.06	10.06	13.86	11.38
S	0.66	0.66	0.66	0.66	0.66	0.66	0.55	0.66
H_2	5.17	5.17	5.17	5.17	4.29	4.29	3.77	5.17
C	59.90	59.90	59.90	59.90	60.54	60.54	56.60	59.90
H_2O	9.60	9.60	9.60	9.60	9.25	9.25	8.18	9.60
N_2	1.22	1.22	1.22	1.22	1.20	1.20	1.09	1.22
O_2	12.07	12.07	12.07	12.07	14.00	14.00	15.95	12.07
Btu/Lb (as received)	10169	10169	10169	10169	10377	10377	9534	10169
Wet Flue Gas Analysis (%) By Volume								
CO_2	13.086	12.730	10.524	10.746	13.549	13.549	11.601	12.796
H_2O	10.053	9.836	8.486	8.622	9.033	9.033	7.670	9.876
SO_2	.054	.053	.043	.044	.055	.055	.042	.053
Gas Emission Data								
NO_x (ppm)	346	563	543	651	863	960	815	634
NO_2 (lb/MM Btu)	0.53	0.90	1.06	1.24	1.29	1.44	1.47	1.00
SO_2 (ppm)	529	511	439	458	510	567	475	541
SO_2 (lb/MM Btu)	1.10	1.09	1.15	1.17	1.06	1.18	1.19	1.15
CO (ppm)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

(a) Burner Excess Air (degree of staging)

Removing the top row of burners from service and using them as overfire air ports permits very significant NO_x reductions to be obtained on this unit. At 75% MCR NO_x was reduced 59% (from the all burners in service case) by opening the idle burner registers 50%; a reduction of 47% was obtained from the case with the top burners out of service and registers closed. However, there was running slag formation during the performance of the lowest NO_x test (No. 1). These tests were performed with unit excess air held approximately constant at 25%. Burner stoichiometry was about 90% for the minimum NO_x test condition.

(b) Unit Excess Air

The effect of unit total excess air shows the same trends as before: a moderate increase of NO_x with excess air during normal firing with all burners in service; a much greater sensitivity is exhibited during staged firing. As with the tests performed on the opposed-fired unit the burners were operating near their maximum design liberation in the region of maximum NO_x sensitivity to excess air. This is demonstrated by the following table:

Load	Burners in Service	NO_x Change with X_S Air	Idle Reg. % Open	Burner Liberation
75% MCR	16	6.67×10^{-3} lb/10^6 Btu/% X_S Air	--	166×10^6 Btu/lb
75% MCR	12	13.6×10^{-3} lb/10^6 Btu/% X_S Air	10%	200×10^6 Btu/lb
75% MCR	12	14.3×10^{-3} lb/10^6 Btu/% X_S Air	50%	200×10^6 Btu/lb

Thus, the sensitivity of NC_x emission to the combined effects of burner turbulence and increased oxygen availability is again demonstrated for the high turbulence Intervane Burner used on this unit.

(c) Unit Load

The variation of NO_x with load is similar to that of the opposed fired unit in that the emission decreases as load is reduced. Unit B demonstrates a slightly greater slope (change in NO_x/ change in load) than does Unit A which may be due to the higher full load NO_x level of single-wall fired units.

(d) Unit Operability

There were no apparent detrimental effects, apart from slagging, to unit performance during the staged firing tests, as indicated by a comparison of unit input to output during normal and staged combustion. CO was monitored during the tests as were combustibles, which were checked on the station combustibles meter. There was no significant increase in CO or combustibles during any of the low NO_x tests.

(e) Furnace Conditions

Furnace conditions were observed, during the testing of this unit, in the same manner as during the test of Unit A. It was found that there were conditions of excess air and staging which would promote the formation of running slag. The following observations were made:

(1) All Burners in Service, Normal Firing Tests: During all of these tests, at 75% MCR or greater, furnace conditions were generally good with bright stable flames. Furnace side and rear walls had a covering dry ash which is considered normal for this unit.

(2) 75% MCR, Top Burners Out of Service: During these staged firing tests excess air was varied from 60% to 25% and idle burner registers were opened from 0% to 50%. When the idle registers were set at 50% open and the unit excess air was about 60% (test 3, Figure 4.5) furnace conditions were about the same as during normal firing; however, active burner stoichiometry was approximately 120%. As excess air was gradually lowered, increased slag formation in the lower furnace was noticed. At 25% excess air (test 1, Figure 4.6) slag was running rapidly on the rear wall. Although data was recorded and showed a NO_x emission of only 0.53 $lb/10^6$ Btu, furnace conditions were totally unacceptable for continuous operation. Burner stoichiometry was approximately 90-95%.

A similar test sequence was performed with excess air constant at about 27%. With idle registers closed furnace conditions were similar to those during normal firing. As idle registers were open toward 50% slag began to run on the rear wall; again when burner stoichiometry was reduced below 95%. The fires were stable but the furnace was very hazy.

4.1.3 Summary of Pre-NSPS Unit Data

The two pre-NSPS steam generators reported here are typical of the designs used by Foster Wheeler just prior to the advent of emission regulations. They therefore have high turbulence burners and high burner zone heat release rates. Figure 4.6 shows some of the normal firing and staged firing data for each unit as NO_x vs. Burner Zone Liberation Rate. Table 4-5 contains a listing of the coal ash characteristics.

Unit B, which is front-wall fired, has a clearly higher NO_x emission than does Unit A, which is opposed-fired. This is a typical result: opposed-firing generates less NO_x than single wall firing, all other factors being the same. Since the burners are basically the same and the fuels are similar it would seem unlikely that the difference in emissions is due to a higher rate of NO_x formation at the burners of the single-wall fired unit. Rather, the major differences in boiler-geometry, bulk gas mixing, combustion gas stratification and cooling rates more likely affect the reverse reaction (NO reducing to N_2 in the burner zone) and char burnout rates.

Significant NO_x reductions were obtained under reduced load conditions, but in both cases a slag threshold was reached, below 95% burner stoichiometry, which would have prevented continuous operation. Although the flame and slag conditions were different in each unit the result was the same: unit availability would have been seriously affected if long term operation had been attempted.

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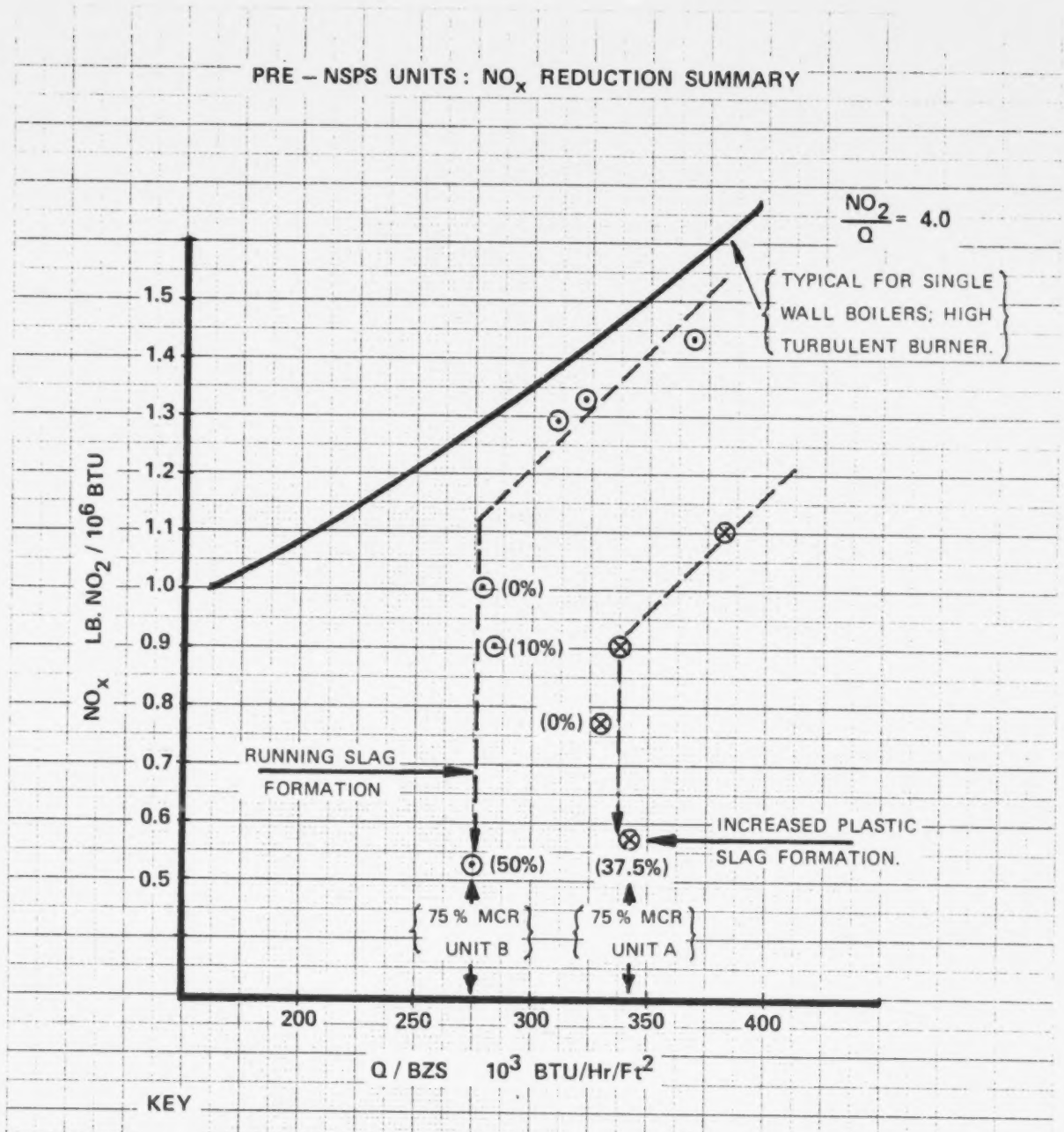


FIGURE 4 – 6

TABLE 4-5. ASH CONSTITUENTS

	Unit A	Unit B
SO_3	6.6	11.0
MgO	1.1	2.5
Na_2O	0.4	0.1
SiO_2	45.6	43.8
Al_2O_3	18.0	14.7
Fe_2O_3	18.4	8.2
CaO	5.6	18.6
K_2O	2.1	1.7
TiO_2	0.8	0.4
P_2O_5	nil	2.1
MaO_5	-	0.1
U_2O_5	-	0.1
Cr_2O_3	-	0.1
MoO_3	-	0.1
NiO	-	0.1
Cl	-	0.1
	98.6	103.7

	Red	Oxid	Red	Oxid
Initial Deform.	2000	2220	2100	2200
Soft. Sph.	2070	2300	2180	2240
Soft. Hem.	2130	2350	2210	2300
Fluid	2180	2410	2240	2550

However, it must be noted that these tests were performed with the intent of obtaining information which would be applicable to new units designed to meet the NSPS; not as a means of developing NO_x controls for these pre-NSPS units. Foster Wheeler does not consider reduced load operation (derating) to be a viable means of controlling NO_x emissions.

The results of these tests, and of similar tests performed on other units, have been Foster Wheeler's recognition that, in general, there is a limit to the degree of staged combustion which is practically achievable on utility steam generators. There can, however, be some specific exceptions where a low sulfur, low slagging potential coal is available.

NO_x emissions are sensitive to load, total excess air and degree of staging (burner excess air). The effect of excess air seems to vary with relative burner loading; that is, whether or not the burner is operating at maximum design liberation during staged combustion. Note that the maximum design liberation itself (burner size) does not affect the NO_x emission: a 100 MM Btu/hr burner can have the same NO_x emission as a 200 MM Btu/hr burner if they are of the same design, firing the same fuel, within furnaces of the same Burner Zone Liberation Rate. Burner design, not liberation, controls NO_x formation.

The results of Foster Wheeler's extensive field test program on pre-NSPS steam generators, of which the information provided here is only a part, have confirmed that staged combustion is a viable means of reducing NO_x emissions. However, in order for this

technique to be acceptable certain precautions must be taken to prevent slag formation or tube wastage. Foster Wheeler uses the following design and operating criteria to control these potential problems:

(1) Larger more conservative furnace designs to provide lower Burner Zone Liberation Rates (cooler furnace), which usually results from a wide variation in performance coal quality.

(2) The staged firing system is generally limited to burner stoichiometries greater than 96% of the theoretical air requirement.

(3) Boundary Air is provided to insure that an oxidizing atmosphere will be maintained along the walls of the burner basket.

(4) A reduced turbulence Intervane Burner permits NO_x levels, with unit design excess air at the burners, to be sufficiently low as to allow the NSPS limit to be attained with burner stoichiometries no less than 96%.

The validity of this design approach has been demonstrated on NSPS units which are currently in operation. A dual register low NO_x burner has also been developed to provide greater flexibility of both design and operation. In most cases with the use of the dual register low NO_x burner the NSPS NO_x regulation should be attainable without also using staged combustion.

4.2 NSPS COAL-FIRED UNITS

The coal-fired steam generators which Foster Wheeler has recently started-up utilize overfire air ports (staged combustion) as the primary means of NO_x reduction: lower Burner Zone Liberation Rates are inherent in the designs. Data are presented from one unit designed to meet the NSPS with the Intervane Burner.

4.2.1 Unit C: Front-Wall Fired

This is a natural circulation reheat type steam generator with a capacity of 929,400 lb. per hour superheated steam at 1975 psig and 1005F at the outlet and 740,200 lb. per hour reheated steam at 469 psig and 1005F at the outlet. It utilizes eight Foster Wheeler Intervane Burners, in a two (wide) by four (high) matrix, supplied by two Foster Wheeler Ball Mill Pulverizers.

The unit has a low Burner Zone Liberation Rate (215,000 Btu/hr/ft^2) and a good quality coal with a relatively low fuel nitrogen content ($<$ 2.8 lb $NO_2/10^6$ Btu). A standard Intervane Burner is used since this unit is similar to other Foster Wheeler units on this station; use of the same burner significantly simplifies the maintenance requirements of the station. The boiler design, fuel quality and use of overfire airports permit the NSPS to be attained without modifying the burner.

Figure 4.7 is a side elevation view of the unit; Table 4-6 contains unit design and performance fuel information.

UNIT C

FOSTER WHEELER

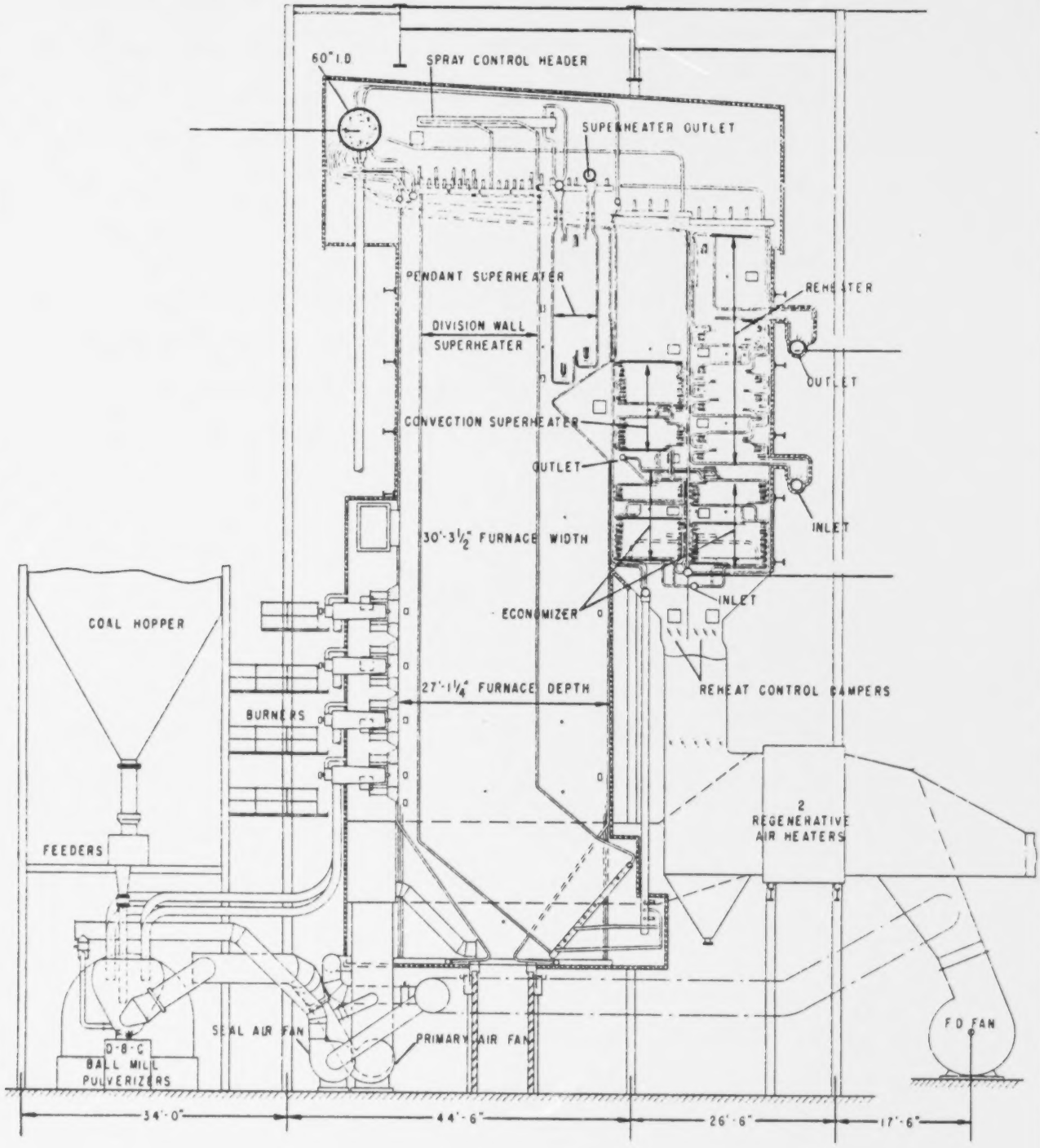


FIGURE 4 – 7

TABLE 4-6. UNIT C DESIGN DATA AND PERFORMANCE FUEL

Each Unit Will Include the Following:

Convection surface boiler	3,492 sq. ft.
Walls in furnace	11,070 sq. ft.
Radiant superheater	8,525 sq. ft.
Convection superheater	19,738 sq. ft.
Reheater I	21,626 sq. ft.
Reheater II	
Economizer (Bare Tube)	22,420 sq. ft.
Air heater	97,600 sq. ft.
Total furnace volume	69,495 cu. ft.
Total furnace surface	20,295 sq. ft.
Firing equipment	Two FW D-8-C Pulverizers

Performance based on fuel specified below:

Grindability	48 (Hardgrove)
Size	1-1/4
Max. moisture	7.2*

Prox. Analysis Percent

Moisture	
Volatile matter	
Fixed carbon	
Ash	
Softg. temp. of ash	R/O 2280/2390

Ultimate Analysis

Percent by	Weight
Ash	7.20
S	0.52
H_2	5.08
C	67.50
H_2O	7.20
N_2	1.10
O_2	11.40
Btu/lb as fired	12,400

* Surface Moisture % 4.2

This unit was characterized with respect to overfire airport operation, excess air and load. Since the unit contains overfire air ports, staged combustion can be attained at full load with all burners in service at maximum design liberation rate.

Figures 4.8 and 4.9 are the composite NO_x and CO plots, respectively, showing the parametric relationships between load, excess air and staging. The relationships are quite similar to those obtained on the pre-NSPS units. The sensitivity to excess air at maximum burner liberation rate is about 14.6×10^{-3} lb/10^6 Btu/% X_S Air which is comparable to that of the older units.

Table 4-7 is a listing of measured test data and applicable fuel analyses.

Furnace conditions were observed during all tests to determine if staged combustion caused any adverse effects on the unit. During all operating conditions flames were stable and there was no change in furnace cleanliness with overfire air ports open or closed. Slag was minimal and considered normal for a boiler of this Burner Zone Liberation Rate firing this particular fuel.

Tube wastage is not considered to be a potential problem. The low sulfur content of the coal and the ash properties provide added confidence for this expectation. However, even if a high sulfur slagging coal had been used, good furnace sidewall conditions would be maintained by proper adjustments to unit and Boundary Air design.

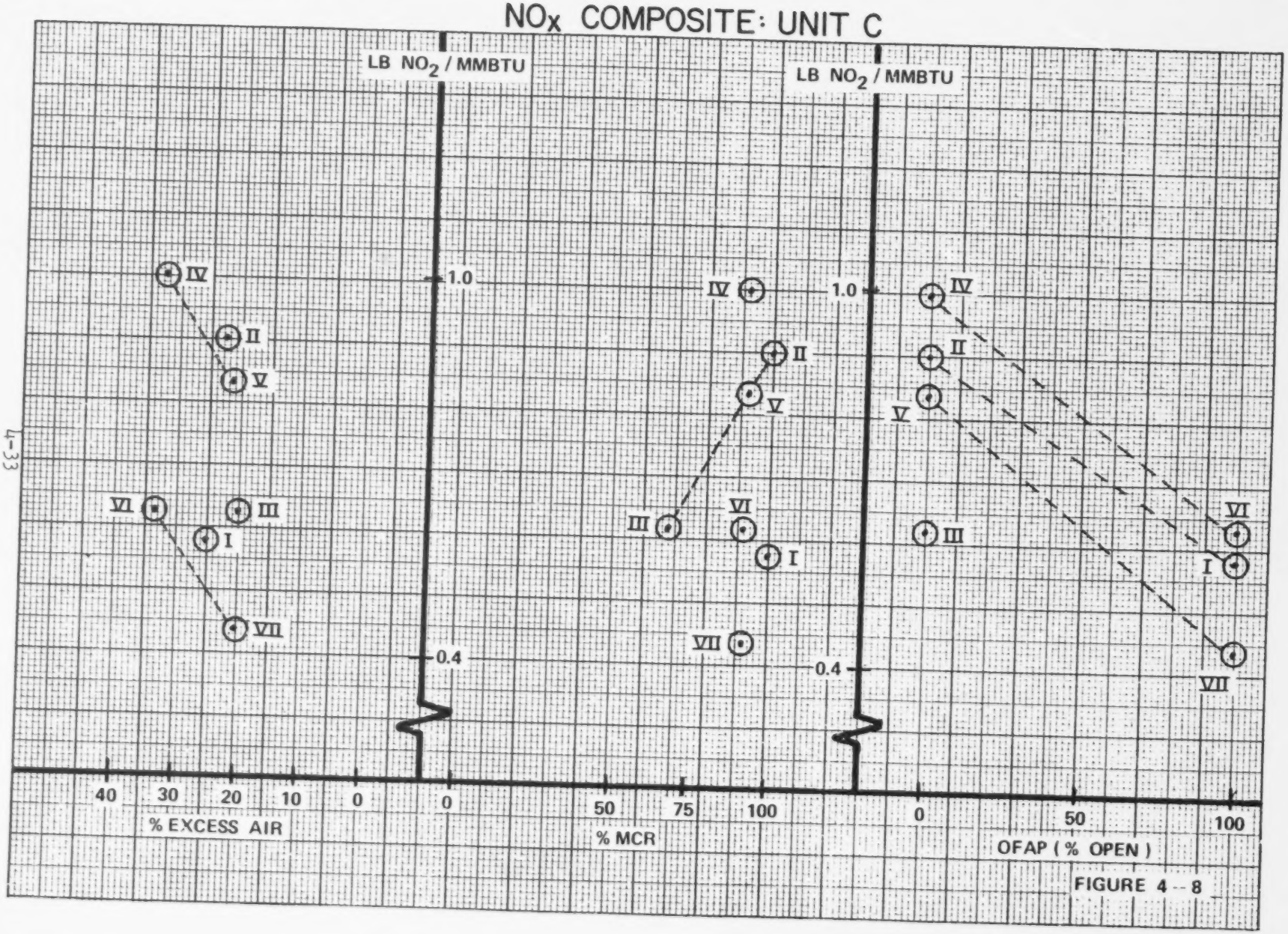

NOx COMPOSITE: UNIT C
LB NO2 / MMBTU
1.0
0.4
IV
II
V
VI
III
I
VII
40
30
20
10
0
% EXCESS AIR
50
75
100
% MCR
OFAP (% OPEN)

FIGURE 4 -- 8

CO COMPOSITE: UNIT C

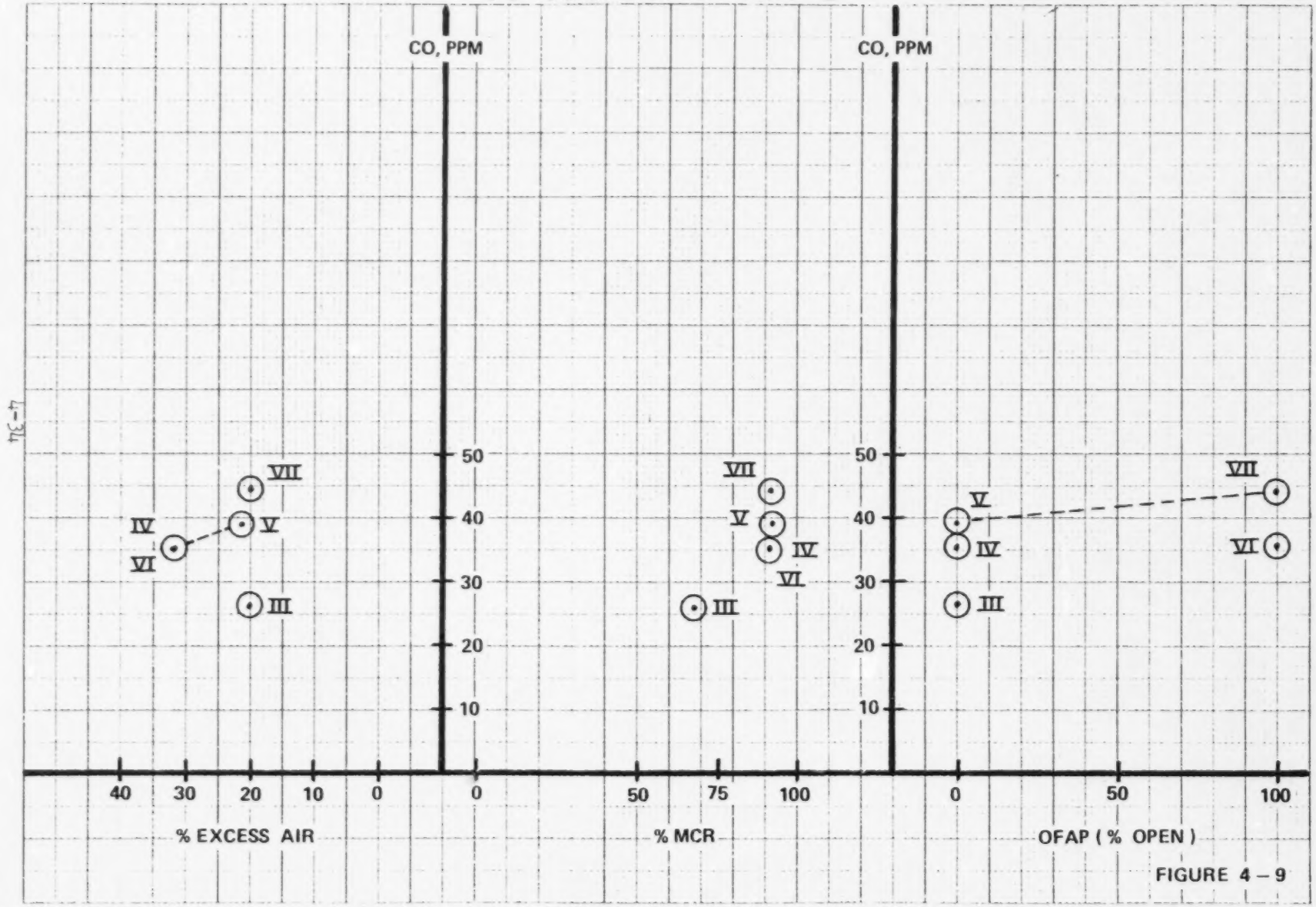


FIGURE 4 – 9

TABLE 4-7. UNIT C TEST DATA

TEST NO.	I	II	III	IV
Steam . . . M lb hr	935	930	637	855
Pressure superheater outlet . . psi	1890	1890	1880	1890
Temperature steam superheater outlet F	993	1000	980	1003
Pressure Boiler Drum . . psi	2104	2102	2003	2142
Reheat steam . . . M lb/hr	746	742	N.A.	N.A.
Temperature steam entering reheater . F	675	677	N.A.	N.A.
Temperature steam leaving reheater . . F	995	1000	980	990
Pressure steam entering reheater . . psi	518	510	N.A.	N.A.
Pressure steam leaving reheater . . psi	500	495	363	500
Temp. feed entering unit . . F	465	463	N.A.	N.A.
Temp. feed leaving econ. . . F	540	547	523	569
Temp. air entering unit . . . F	40	51	119	100
Temp. air leaving air heater . . F	547	565	566	582
Temp. gas leaving furnace . . F	N.A.	N.A.	N.A.	N.A.
Temp. gas leaving boiler . . F	N.A.	N.A.	N.A.	N.A.
Temp. gas leaving economizer			673	713
Temp. gas leaving air heater . . F	697	706	N.A.	N.A.
Ditto corrected for leakage	298	311	338	351
Excess air leaving . . %	25.1	21.6	20	32.3
Wet gas entering air heater . . M lb/hr	1276	1236	814	1231
Wet gas leaving air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air entering air heater . . M lb/hr	N.A.	N.A.	N.A.	N.A.
Air leaving air heater . . M lb/hr	1183	1143	751	1144
Draft in furnace . . in. H_2O	-0.75	-0.60	-0.70	-1.0
Air & gas loss total . . in. H_2O	N.A.	N.A.	N.A.	N.A.
Pressure loss Drum to Sho Hdr . . psi	214	212	123	252
Fuel burned . . M lb/hr	102	101.9	68	94
Liberation, total val. . . Btu/hr x cu ft.	17,930	17,920	11,922	16,482
Furn. cooling factor net . Btu/hr x sq. ft.	61,395	61,361	40,827	56,437
Heat Losses				
Dry gas . . %	6.03	5.896	4.864	6.12
Hydrogen and moisture in fuel . . %	5.25	5.23	5.06	5.176
Moisture in air . . %	.145	.142	.117	.148
Unburned combustible . . %	.35	.35	.35	.35
Radiation . . %	.25	.25	.25	.25
Unaccounted for . . %	.50	.50	.50	.50
Total losses . . %	12.51	12.368	11.14	12.54
Efficiency . . %	87.49	87.63	88.86	87.46
Overfire Airport (% open)	100	0	0	0

TABLE 4-7 TEST DATA

TEST NO.		V	VI	VII
Steam	M lb. hr.	865	861	860
Pressure superheater outlet	psi	1893	1885	1882
Temperature steam superheater outlet	F	980	965	988
Pressure Boiler . Drum		2144	2145	2102
Reheat steam		N.A.	N.A.	N.A.
Temperature steam entering reheater	F	N.A.	N.A.	N.A.
Temperature steam leaving reheater	F	977	960	985
Pressure steam entering reheater	psi	N.A.	N.A.	N.A.
Pressure steam leaving reheater	psi	502	502	502
Temp feed entering unit	F	N.A.	N.A.	N.A.
Temp feed leaving econ	F	552	549	559
Temp air entering unit	F	116	107	110
Temp air leaving air heater	F	582	566	576
Temp gas leaving furnace	F	N.A.	N.A.	N.A.
Temp gas leaving boiler	F	N.A.	N.A.	N.A.
Temp gas leaving economizer	F	704	696	705
Temp gas leaving air heater	F	N.A.	N.A.	N.A.
Ditto corrected for leakage	F	353	346	350
Excess air leaving	%	19.9	33.8	20.1
Wet gas entering air heater	M lb/hr	1088	1224	1119
Wet gas leaving air heater	M lb/hr	N.A.	N.A.	N.A.
Air entering air heater	M lb/hr	N.A.	N.A.	N.A.
Air leaving air heater	M lb/hr	1004	1139	1033
Draft in furnace	in. H_2O	-0.90	-0.80	-0.75
Air & gas loss total	in. H_2O	N.A.	N.A.	N.A.
Pressure loss Drum to SHO HDR	psi	251	260	220
Fuel burned	M lb/hr	91	92	93
Liberation, total vol	Btu/hr x cu ft	15956	16155	16330
Furn. cooling Factor net	Btu/hr x sq ft	54636	[illegible]	55919
Heat Losses:				
Dry Gas	%	5.26	5.922	5.356
Hydrogen & moisture in fuel	%	5.11	5.094	5.088
Moisture in air	%	.13	.143	.129
Unburned combustible	%	.35	.35	.35
Radiation	%	.25	.25	.25
Unaccounted for	%	.50	.50	.50
Total losses	%	11.60	12.26	11.67
Efficiency	%	88.40	87.74	88.33
Overfire Airport (% open)		0	100	100

TABLE 4-7. UNIT C TEST DATA

TEST NO.	I & II	III & IV	V	VI	VII
Prox. Analysis (%)					
Moisture	5.86	6.92	6.92	6.39	6.39
Volatile Matter	43.61	40.81	40.81	42.21	42.21
Fixed Carbon	42.43	44.89	44.89	43.66	43.66
Ash	8.10	7.38	7.38	7.74	7.74
Ult. Analysis (%) By Weight					
Ash	8.10	7.38	7.38	7.74	7.74
S	0.50	0.24	0.24	0.37	0.37
H_2	5.40	5.36	5.36	5.38	5.38
C	67.78	67.34	67.34	67.56	67.56
H_2O	5.86	6.92	6.92	6.39	6.39
N_2	1.04	0.82	0.82	0.93	0.93
O_2	11.32	11.94	11.94	11.63	11.63
Btu/lb (as fired)	12,221	12,185	12,185	12,203	12,203
Wet Flue Gas Analysis by Volume					
% CO_2	13.259/ 13.621	13.830/ 12.606	13.841	12.453	13.801
% H_2O	9.005/ 9.195	9.445/ 8.790	9.451	8.645	9.360
% SO_2	.037/ .037	.018/ .017	.018	.026	.028
Gas Emission Data					
NO_x (ppm)	390/630	450/660	601	398	307
NO_2 (Lb/10^6 Btu)	0.575/ 0.901	0.623/ 1.011	0.832	0.619	0.428
SO_2 (ppm)	N.A./N.A.	N.A./N.A.	N.A.	N.A.	N.A.
CO (ppm)	N.A./N.A.	26/35	39	35	44

TABLE 4-8. UNIT C TYPICAL ASH CONSTITUENTS

SO_3	6.4	9.4
MgO	2.1	1.6
Na_2O	1.3	1.9
SiO_2	56.8	43.1
Al_2O_3	17.0	14.8
Fe_2O_3	5.1	7.0
CaO	8.1	17.9
K_2O	2.1	0.4
TiO_2	0.9	0.8
P_2O_5	0.2	0.2

Air Fusion Temp. (°F)	Red/Oxid	Red/Oxid
Initial Deform.	2040/2140	2000/2060
Soft. Sph.	2120/2200	2020/2080
Soft. Hem.	2160/2240	2060/2110
Fluid	2420/2500	2200/2340

Note: These samples were taken prior to the test series reported here. Ash analyses were not performed during the NO_x tests.

Figure 4-10 shows the NO_x emission, at full load, as a function of Burner Zone Liberation Rate compared to a typical full-load curve (the development of this curve is as explained for Figure 2.2). This figure also contains two measured data points from another single wall fired NSPS unit. The second unit uses a coal with a higher nitrogen content, approximately 3.6 lb $NO_2/10^6$ Btu, and was equipped with a reduced turbulence Intervane Burner. The predicted emission point represents that NO_x level which would be expected if the high turbulent Intervane Burner had been used. The measured data point is about 17% lower and confirms the effectiveness of the reduced turbulence design. It is, therefore, possible to fit the burner and furnace designs to the coal so as to prevent violating our 96% minimum stoichiometry limitation.

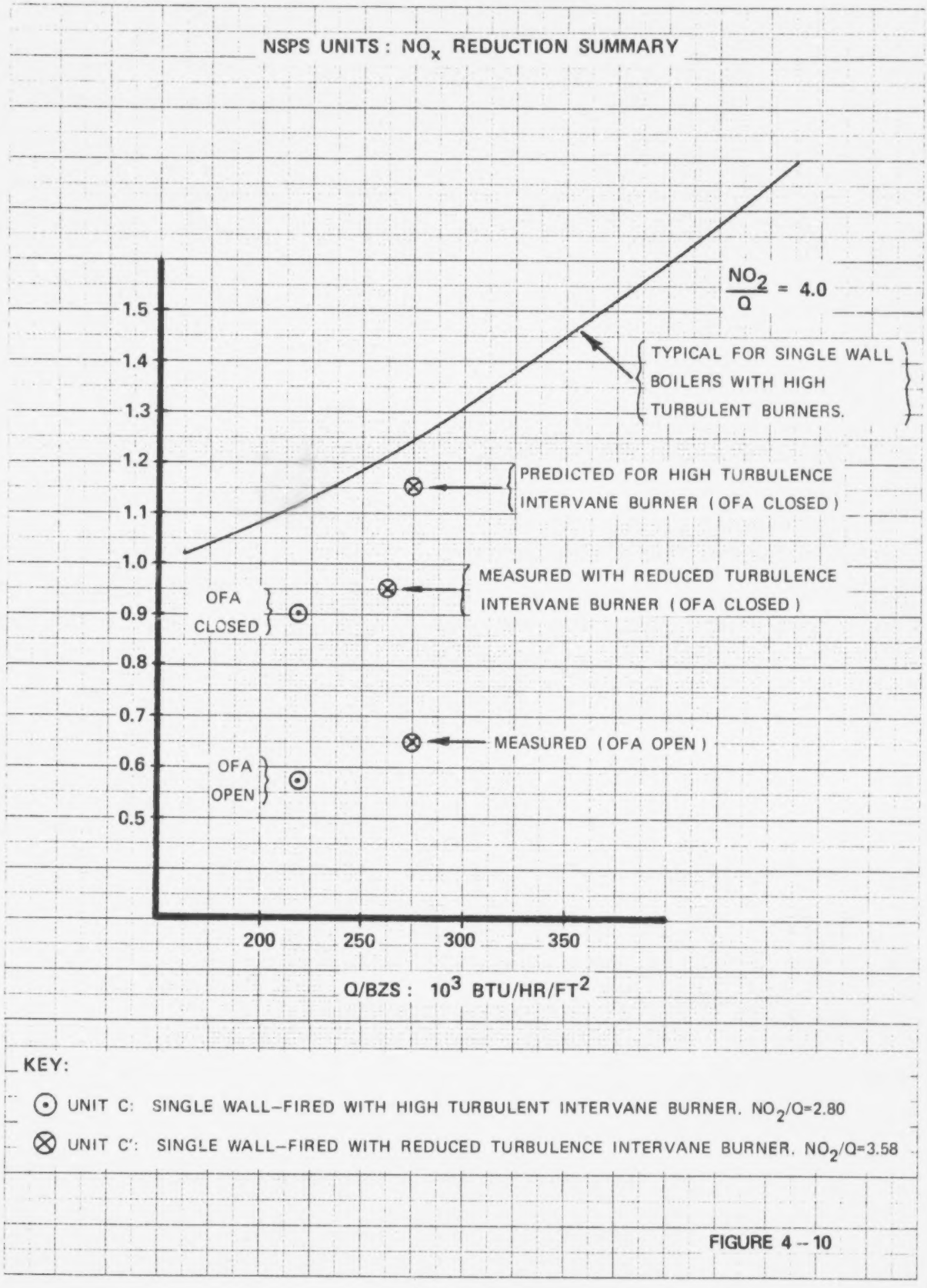

NSPS UNITS : NO_x REDUCTION SUMMARY
$\frac{NO_2}{Q}$ = 4.0
TYPICAL FOR SINGLE WALL BOILERS WITH HIGH TURBULENT BURNERS.
PREDICTED FOR HIGH TURBULENCE INTERVANE BURNER (OFA CLOSED)
MEASURED WITH REDUCED TURBULENCE INTERVANE BURNER (OFA CLOSED)
OFA CLOSED
MEASURED (OFA OPEN)
OFA OPEN
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
200
250
300
350
Q/BZS : 10^3 BTU/HR/FT^2
KEY:
UNIT C: SINGLE WALL-FIRED WITH HIGH TURBULENT INTERVANE BURNER. NO_2/Q=2.80
UNIT C': SINGLE WALL-FIRED WITH REDUCED TURBULENCE INTERVANE BURNER. NO_2/Q=3.58

FIGURE 4 -- 10

4.3 LOW NO_x BURNER TEST DATA

Foster Wheeler has developed a dual register, dual throat, coal burner which is inherently low in NO_x emissions. The burner, which has been functionally discussed in Section 2.2C and shown in Figure 2.6, was developed on a four burner industrial-sized steam generator test facility.

Although the NSPS of 0.7 lb $NO_2/10^6$ Btu has been attained, using the previously-explained design philosophy, the need for a more advanced burner design was also recognized. This would permit greater design and operational flexibility. In particular, the possible need for substoichiometric firing with some high nitrogen low heating value coals could be eliminated. This goal has been achieved by the successful operation of the low NO_x dual throat coal burner.

Utility experience with this burner has been obtained on three older, operational steam generators in Japan. These units, two 265 MWe opposed-fired and one 75 MWe front-wall fired, were retrofitted with dual register burner designs functionally identical to that of Figure 2.6. When designed in the early 1960's these units had no NO_x controls. They were designed for 20 percent excess air operation, with all air through the burners. All units were equipped with Foster Wheeler Ball Mills. These three units are all located in Japan and were designed and fabricated by Foster Wheeler's licensee Ishikawajima-Harima Heavy Industries, Ltd. (IHI), in cooperation with Foster Wheeler.

The opposed-fired units were later equipped with overfire air ports for NO_x control, with the original Intervane Burner. However, the boilers could not

be operated with overfire air ports 100% open for more than 8-12 hours due to increased slag buildup in the lower furnace, along the sidewalls and around the burner throats. This situation was caused by the lower furnace reducing atmosphere which results when the overfire airports on these units are 100% open and precluded long term continuous minimum NO_x operation. However, with overfire air ports 100% open NO_x reductions of 30% were obtained.

Since 1976 all three units have been retrofitted with a dual throat low NO_x burner, Figure 4.11 shows results typical of one of the 265 MWe steam generators.

The unit design is similar to that of Unit A in Figure 4.1. Twenty-four burners are utilized, 12 per firing wall in a 4 wide x 3 high arrangement. It is a natural circulation reheat type steam generator with a capacity of 1,848,000 lb per hour superheated steam at 2500 psig and 1050F at the outlet.

NO_x emissions have been reduced approximately 48% by the low NO_x burner only (overfire airports closed) as compared to the high turbulent Intervane Burner. When overfire airports are 100% open the total NO_x reduction is about 67%. Boundary air was also retrofitted to these units at the same time as the low NO_x burners. The slagging situation has been substantially alleviated, though not eliminated when overfire air ports are 100% open, by the combined effect of the low NO_x burners' cooler, less turbulent flame and the lower furnace oxidizing atmosphere provided by Boundary Air.

NO_x EMISSIONS

265 MW_e UTILITY BOILER

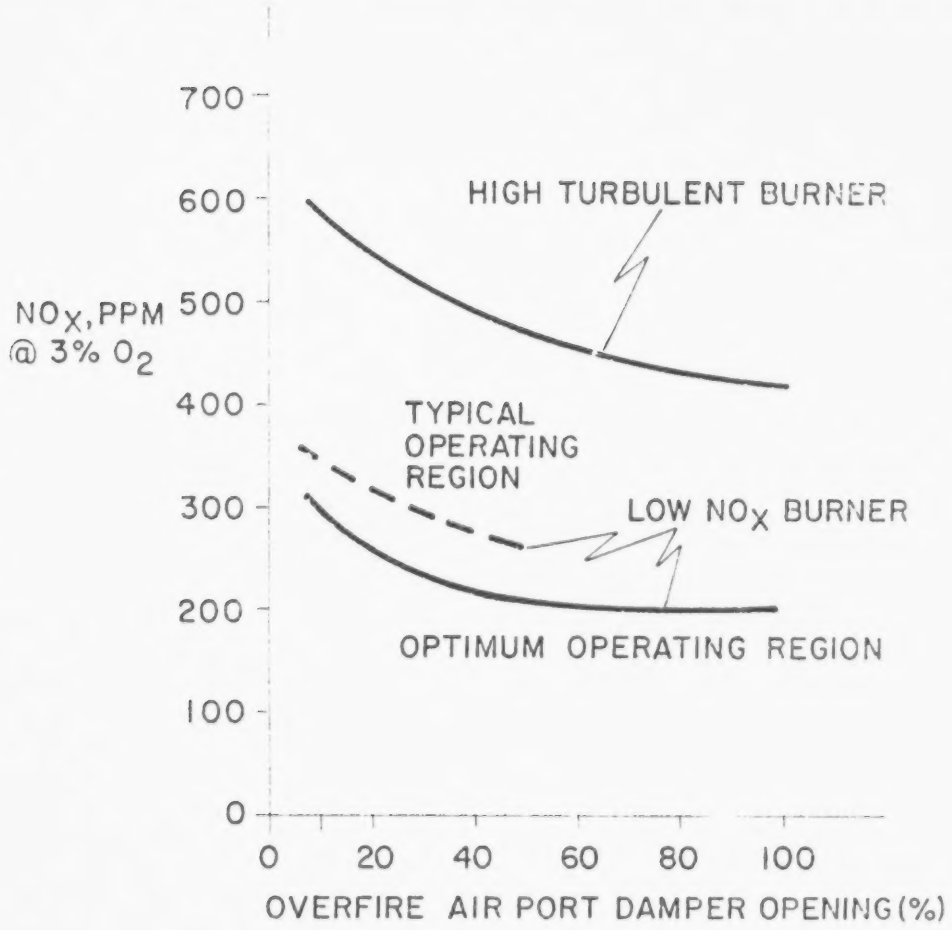


FIGURE 4 – 11

After installation of the dual register burner, unit performance is virtually the same as with the initial design. There were no detrimental effects to any aspects of steam generator operability. However, with overfire airports there is an increase in unburned carbon in the ash; this increase is still well within acceptable limits. The following table compares emissions performance under various operating conditions:

Burner Type	OFAP (% Open)	NO_x (ppm @ 3% O_2)	O_2 (%)	Unburned Carbon (% in Flyash)
Intervane	min. (cooling air)	600	3.4	1.50
Intervane	100	425	3.4	2.5
Low NO_x	min. (cooling air)	310	3.5	1.50
Low NO_x	100	200	3.6	2.5

Tests were performed with coal having the following typical properties:

Volatile Matter	41.8%
Fixed Carbon	30.1
Sulfur	0.45
Nitrogen	1.18
Moisture	12.1
Ash	15.2
HHV	11,500 Btu/lb

Note that, for this coal, an additional 1% unburned carbon represents an efficiency loss of 0.19% and that the unburned carbon levels for the Intervane and low NO_x burners are the same. The combined use of overfire airports and low NO_x burner has only a marginal effect on unit efficiency.

Foster Wheeler's experience with low NO_x coal burners has been obtained on four older steam generators which had been initially equipped with the Intervane Burner and later retrofitted with dual register burners. The steam generators capacities range from 125,000 lb/hr steam flow (four burners) to 1,850,000 lb/hr (24 burners). It is clear from these experiences that combustion efficiency is the same with the low NO_x burner as with the Intervane Burner.

Although there is an increase in unburned carbon when overfire air ports are 100% open, with both types of burners, unit efficiency remains within guarantee limits. However, the long term effect on unit performance, of combining low NO_x burners with overfire air ports, is not yet fully quantified.

5.0 COST DIFFERENTIAL FOR EMISSION CONTROLS

The low-NO_x system utilized by Foster Wheeler consists of a low-NO_x dual register burner, overfire air ports and Boundary Air. Although these components have all been proven on operating utility steam generators (overfire airports and Boundary Air on NSPS units and the complete system on retrofitted pre-NSPS units) and this system has been sold on a number of new units, it is not yet in operation on a new NSPS steam generator. Consequently, a direct cost comparison between two units, an NSPS unit equipped with the complete NO_x control system and a similar pre-NSPS unit, is not possible.

In order to develop a meaningful cost differential imposed by the addition of NO_x controls the following procedure has been used:

A recently sold NSPS steam generator, Unit D, containing the complete NO_x control system has been used as a baseline. The cost increase imposed by the NSPS has been evaluated in two ways:

(1) The cost increment imposed by the use of <u>active</u> NO_x control measures (i.e., low emission burners, overfire air ports) was estimated by comparing the cost of unit D as sold with the cost of that unit if it were redesigned without any NO_x controls. When redesigning the unit, the following constraints were applied:

   (a) The lower furnace was sized according to the burner spacings and Burner Zone Liberation Rate used in pre-NSPS units of this type.

   (b) Exit gas temperature, and therefore total furnace surface, was maintained the same as the NSPS unit.

(c) Partial division wall (radiant superheater) surface was maintained the same as the NSPS unit.

(d) The Heat Recovery Area was not changed; since the inlet and outlet gas temperatures were held constant it was assumed that the cost of this portion of the unit would not change, even if there were some minor dimensional changes.

(2) The cost increment imposed by increasing boiler size (increasing cooling surface area can be considered to a passive NO_x and slag control measure) has been estimated by comparing the cost of Unit D, as reconfigured to the pre-NSPS design, with that of Unit A. It will be recalled that Unit A is a pre-NSPS unit firing high sulfur bituminous coal and represents the latest pre-NSPS boiler design. As such it can be used to provide a baseline against which the larger pre-NSPS Unit D design can be compared. The result of such a comparison would be the cost increase due to changes in furnace structure and associated equipment related to differences in fuel quality.

Figure 5.1 shows an outline drawing of NSPS unit as sold in 1977. The unit utilizes 24 dual register low-NO_x burners, 12 per firing wall in a 4 wide x 3 high arrangement, supplied by six Foster Wheeler medium speed MB-23 pulverizers. It is a natural circulation reheat type steam generator with a capacity of 3,800,000 lb. per hour superheated steam at 2630 psig and 1005F at the outlet and 3,300,000 lb. per hour reheated steam at 580 psig and 1005F at the outlet. Table 5-1 contains the unit design and fuel parameters.

Figure 5.2 shows an outline drawing of this unit reconfigured as a pre-NSPS design. The following is a tabulation of the changes considered as the boiler is reconfigured from the NSPS design to the pre-NSPS design.

(1) Emission Control Equipment

(a) Low NO_x burners (replaced by Intervane burner)

(b) Overfire air ports (eliminate)

(c) Boundary air system (elimimate)

(2) Boiler Structure (reduced plan area; increased height)

(a) Structural steel (reduced)

(b) Windbox size (reduced by eliminating OFA port supply)

(c) Erosion baffles (reduced)

(d) Furnace seals (reduced)

(3) Circulation System

(a) Waterwall panels (decreased number)

(b) Downcomers (increased length)

(4) Field Erection

The effect of all modifications on the number of field labor man-hours has been estimated.

When all of the above are considered, the cost differential due to the active NO_x controls is obtained. If this differential only is considered a biased viewpoint regarding the impact of the NSPS on boiler design will be obtained. This is due to the requirement that sufficient cooling surface be available when overfire airports are used with most coals, particularly those with high sulfur and iron contents. Data has been presented earlier, in Section

4.0, which demonstrates that off-stoichiometric combustion is unacceptable with pre-NSPS units which have high Burner Zone Liberation Rates, such as units A and B.

Also, no such pre-NSPS units have been retrofitted with low emission burners (those that were have cooler furnaces usually with at least one full division wall). It has, therefore, not yet been demonstrated that the pre-NSPS high Burner Zone Liberation Rate design can accommodate a low emission burner.

In order to obtain a realistic indication of the cost of a new NSPS unit, with respect to the more typical high Burner Zone Liberation Rate units, the increase in furnace size (to provide lower Burner Zone Liberation Rates) must be taken into account. We must also note that unit D was designed to use a low-sulfur sub-bituminous coal which also requires a larger furnace. If there were no NSPS sulfur regulations it is possible that this unit could have used a bituminous coal similar to that used by Unit A.

Thus, when all factors are considered the following relative costs are incurred due to the NSPS regulations:

Boiler Design	Relative Cost
1. Unit A (pre-NSPS base design)	100%
2. Unit D (large furnace; no active NO_x controls)	114%
3. Unit D (NSPS design; large furnace, low NO_x burner, overfire airports)	115.5%

It is apparent that the cost of combustion modifications is significantly lower than the cost of increasing furnace size to accommodate those modifications. However, it must also be recognized that low emission burners presently being sold commercially are first generation equipment. As more

UNIT D: NSPS CONFIGURATION

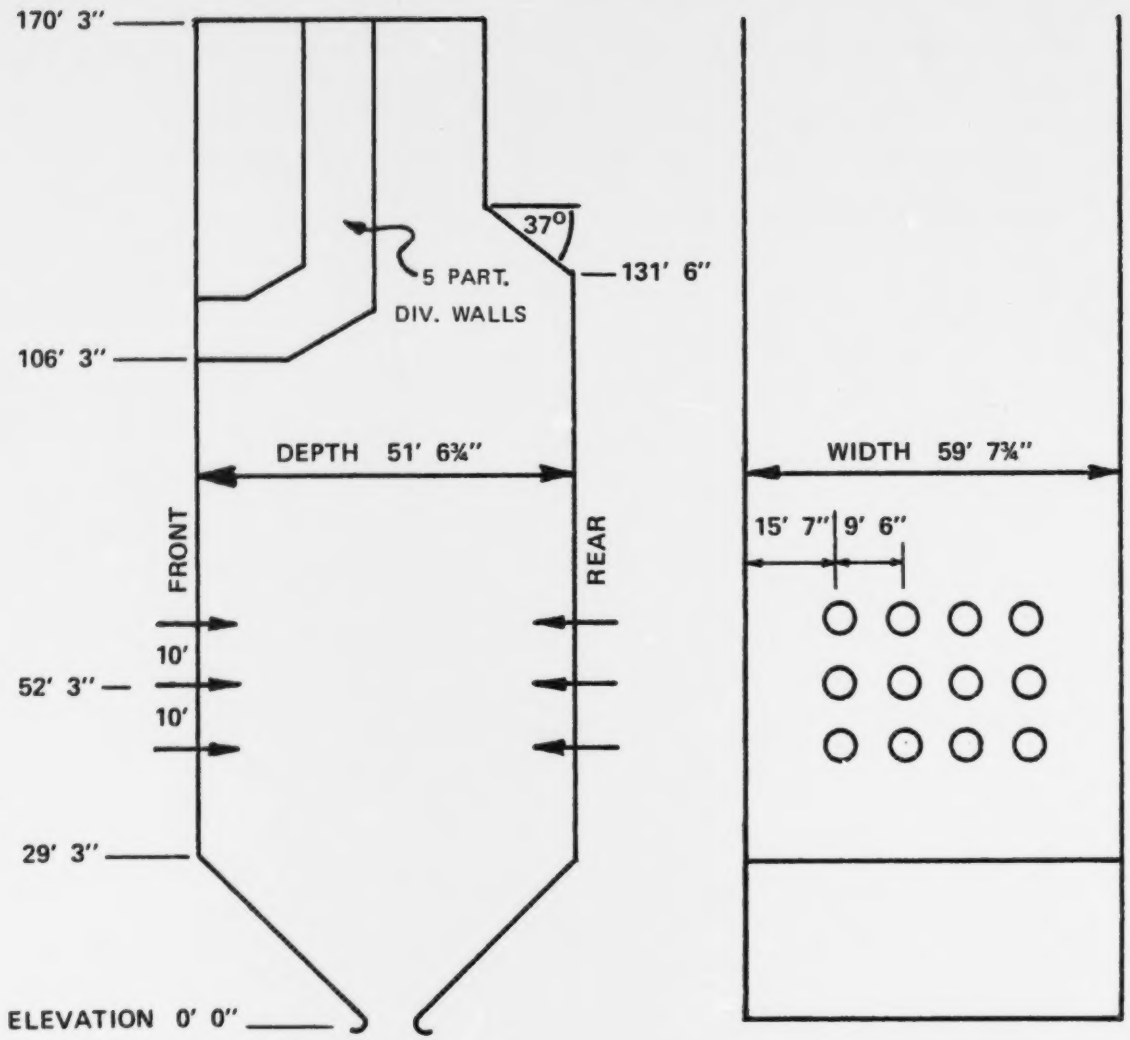
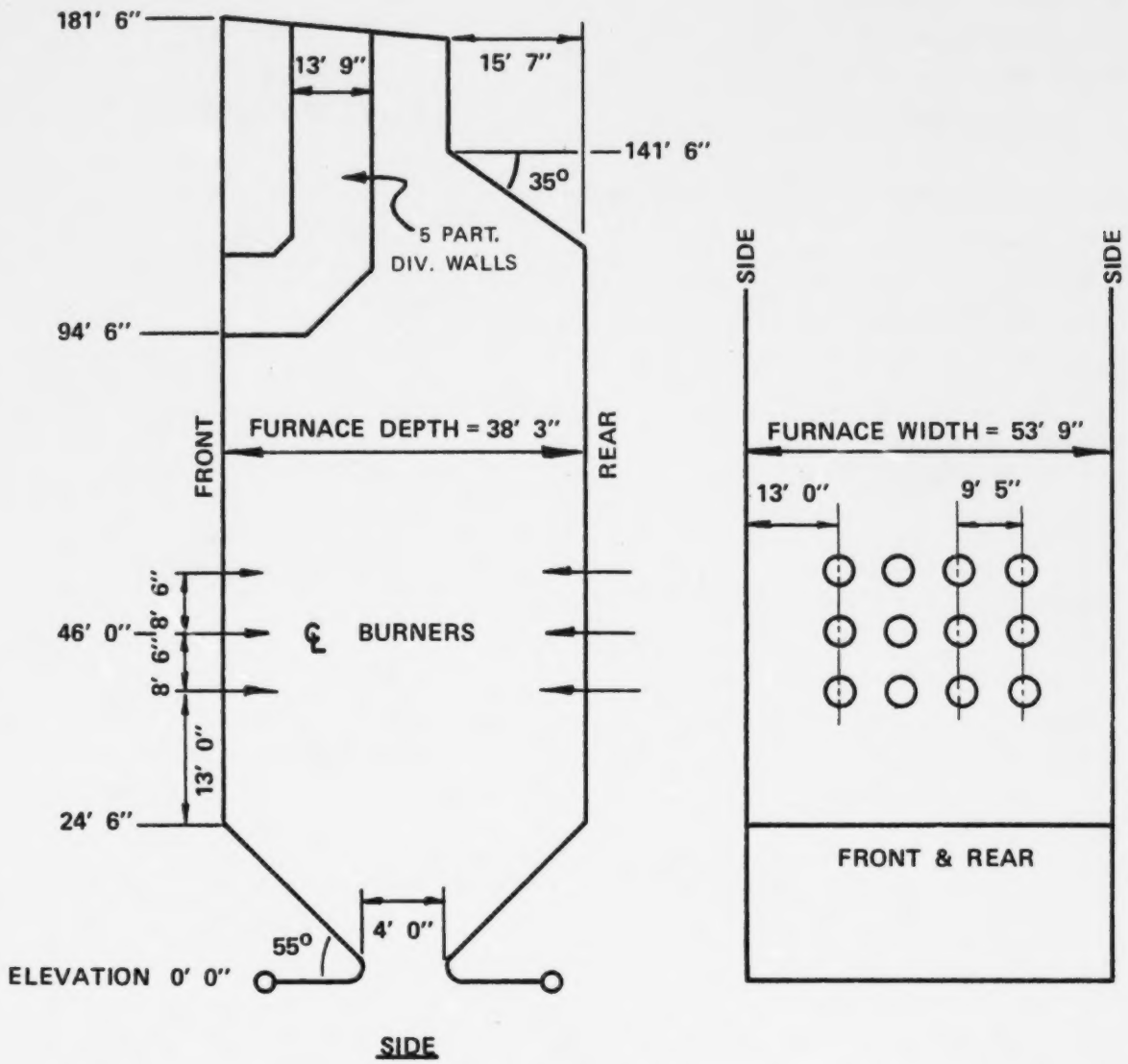


FIGURE 5 – 1

UNIT D: PRE – NSPS CONFIGURATION



SIDE

FIGURE 5 – 2

TABLE 5-1. UNIT D DESIGN DATA AND PERFORMANCE FUEL

Convection surface boiler	4,900 sq. ft.
Water walls in furnace	36,043 sq. ft.
Radiant Superheater	37,275 sq. ft.
Convection Superheater	60,925 sq. ft.
Reheater	106,040 sq. ft.
Economizer	131,307 sq. ft.
Air heater, Trisector	1,036,000 sq. ft.
Total furnace volume	472,260 cu. ft.
Total furnace surface	74,988 sq. ft.
Firing Equipment	Six FW MB Pulverizers
Performance based on fuel specified below:	
Grindability	52 (Hardgrove)
Size	1-1/4 x 0
Max. moisture (%)	29.0
Surface moisture (5)	17.4
Ultimate Analysis	
C (% by weight)	48.48
H_2	3.50
S	0.50
N_2	0.70
O_2	12.00
Ash	5.78
H_2O	29.00
HHV (as fired)	8520 Btu/lb as rec'd.

6.0 OIL FIRED UNIT RETRO-FIT FOR NO_x CONTROL

6.1 CHRONOLOGY OF UNIT PERFORMANCE MODIFICATION

Unit E is a natural gas and oil fired, supercritical once-through, reheat steam generator. It is rated at 5,600,000 lb/hr main steam flow at 1005F and 4,700,000 lb/hr of reheat steam at 1005F. Firing equipment consists of 32 Foster Wheeler intervane burners arranged in four rows, four columns wide on both the front and rear furnace walls.

This unit was designed just prior to the implementation of emission regulations for NO_x emissions. It was designed primarily for natural gas firing and has a burner zone liberation rate of 725,000 Btu/hr-ft^2. Because of limited gas supplies the unit has operated almost exclusively with oil fuel. Figure 6.1 shows the arrangement of the steam generator and Table 6-1 lists the design performance parameters.

In anticipation of forthcoming emissions regulations the unit was designed with overfire air ports and a guarantee limit of 500 ppm of NO_x at 3% O_2 was set. During construction it became apparent that the local authority would set the NO_x limitation at 250 ppm for both oil and gas fuels. In order to meet this regulation, a flue gas recirculation system was added. The addition of the flue gas recirculation system increased velocities through the burners in excess of optimum values.

A test program was initiated after the start-up of the unit (December 1971) to determine NO_x emission compliance status. During this program the NO_x control capabilities of overfire air ports, off-stoichiometric firing and flue gas recirculation were determined. These techniques were evaluated individually and in combination to obtain maximum NO_x reduction capability.

FIGURE 6.1

UNIT E PRE NSPS OIL & GAS FIRED

(RETROFITTED FOR NO_x CONTROLS)

FOSTER WHEELER

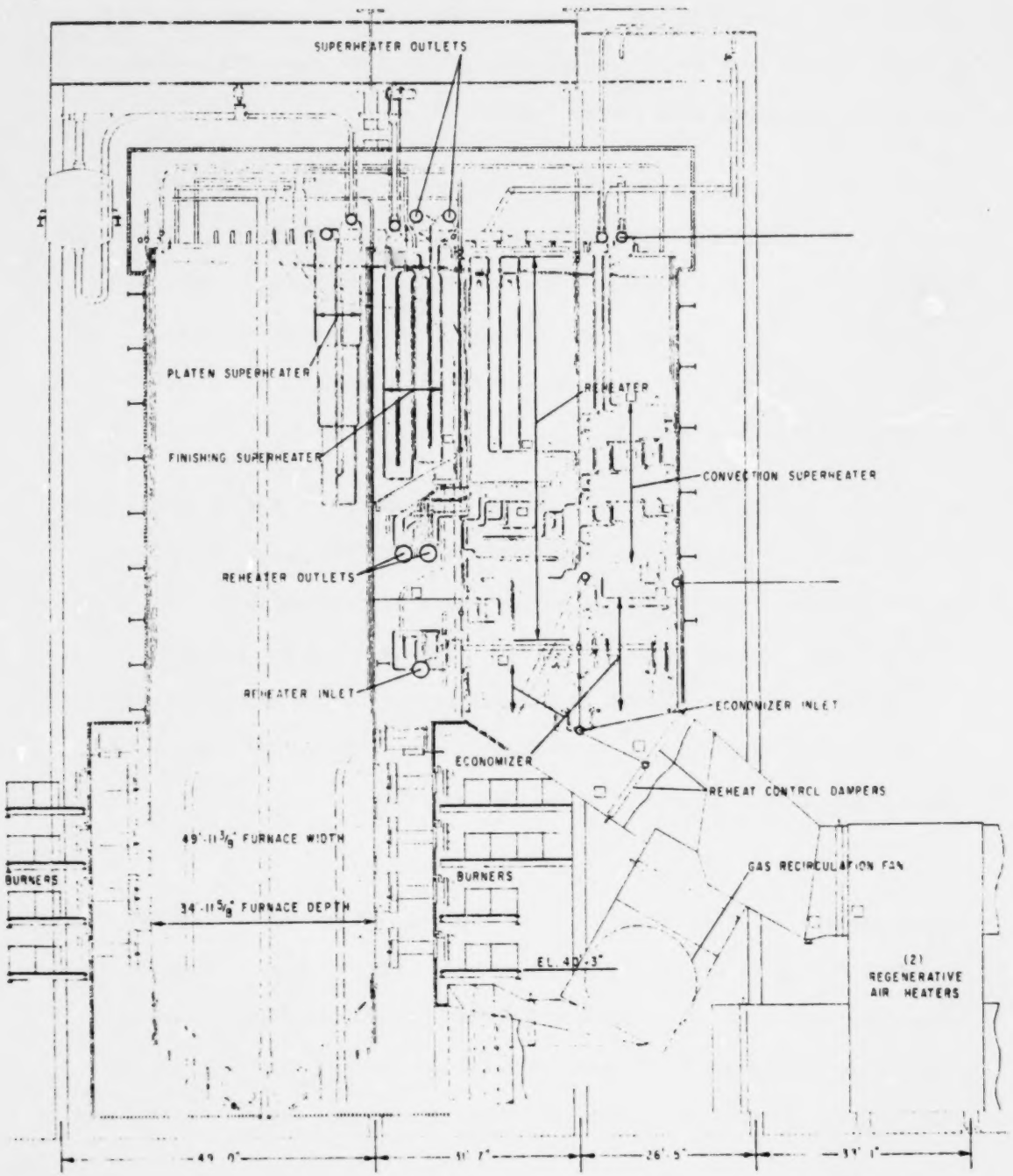


TABLE 6-1. UNIT 3 DESIGN DATA AND PERFORMANCE FUELS

Walls in Furnace	22,165 sq. ft.
Radiant Superheater	15,276 sq. ft.
Convection Superheater	110,445 sq. ft.
Reheater I	82,880 sq. ft.
Economizer ext. sur.	172,600 sq. ft.
Air Heater (2)	343,800 sq. ft.
Total Furnace Volume	208,450 cu. ft.
Total Furnace Surface	37,441 sq. ft.

Ultimate Analysis

Fuel	Natural Gas
Per cent by	Volume
C_4	0.4
CH_4	86.5
C_2H_4	
C_2H_6	8.2
CO_2	0.4
C_3H_8	1.9
N_2	2.6
Btu/lb as fired	22,429
Btu/cu ft @ F-30 in. Hg.	1085

Fuel	No. 6 Oil
Per cent by	Weight
Ash	0.06
S	1.70
H_2	9.90
C	86.29
H_2O	1.00
N_2	1.00
O_2	0.05
Btu/lb as fired	18,000

The emission obtained for these firing modes during oil fired operation are shown in Figure 6-2, Curves A through D.

The combined effect of these NO_x reduction techniques permitted oil fuel operation, in compliance, at loads up to 630 MW. Operational problems resulted from the application of the NO_x control techniques, however, and load capability, due to boiler vibration, was limited to 600 MW. At loads above 600 MW, burner flame instability induced a condition of boiler vibration that was unacceptable for continuous operation.

In order to improve the unit load capability, modifications were made to the steam generator and a test program was initiated in March 1973.

The purpose of this program was to evaluate the following items with respect to NO_x emissions and boiler vibration:

1. Optimization of burner pattern and increased number of burners out of service.

2. Experimental burner modifications.

3. Enlargement of the overfire air ports.

6.1.1 Optimization of Burners Out-of-Service Pattern

In March 1973, a program was initiated to optimize the off-stoichiometric combustion operating procedures for oil fuel at Unit E. This program involved selectively removing up to 25 percent of the burners (8 of 32) from service in such a manner as to minimize NO_x formation. The result of this phase of testing was to increase NO_x compliance

FIGURE 6-2 INITIAL TEST RESULTS

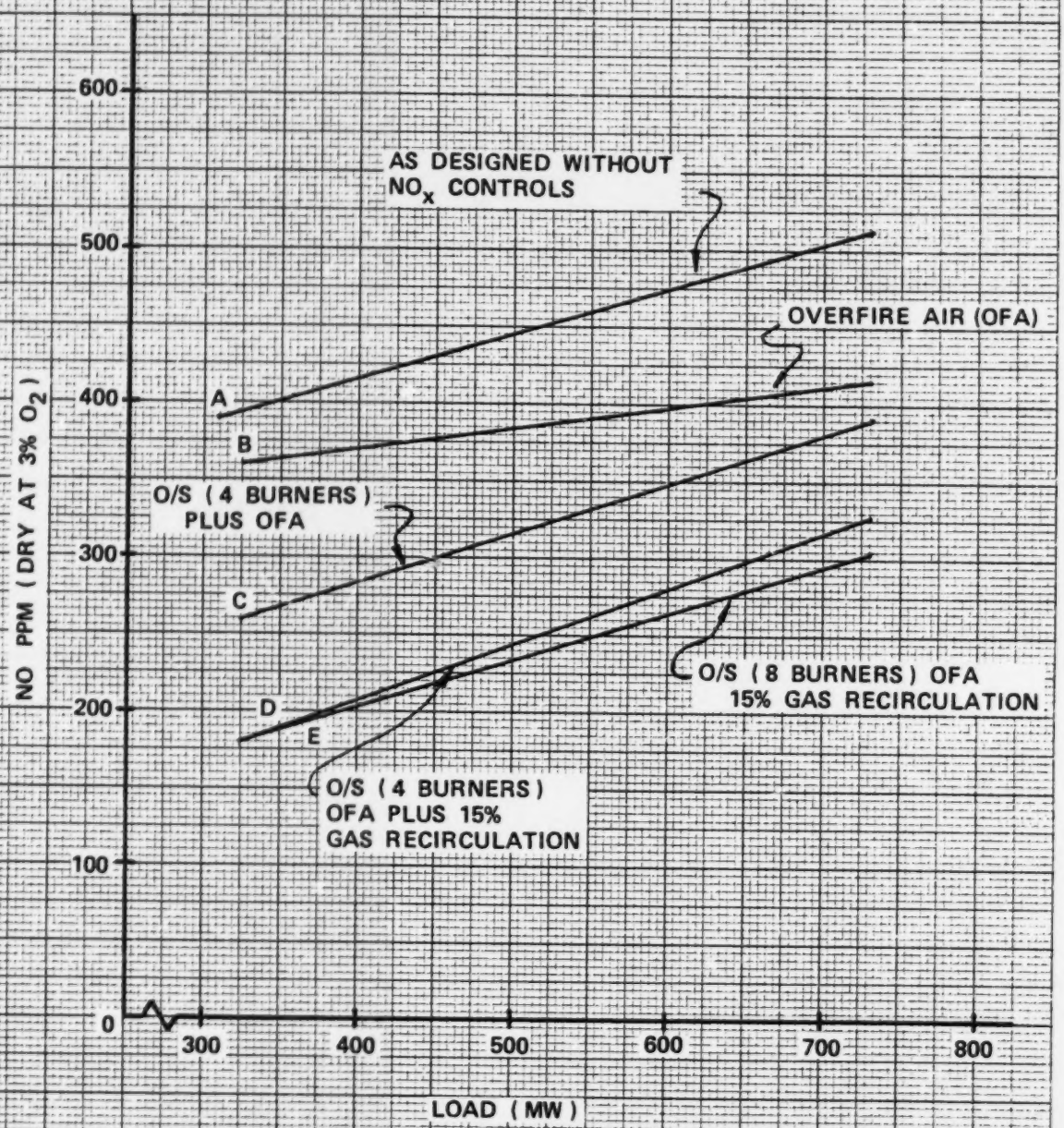
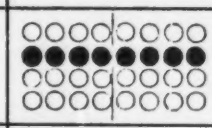
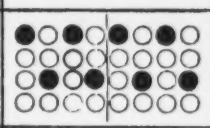
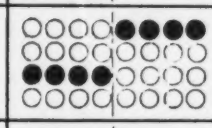
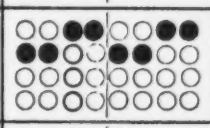
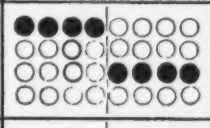
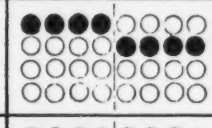
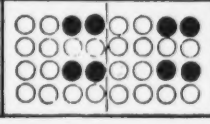
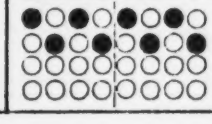


TABLE 6-2

BURNER OUT OF SERVICE

TEST PATTERNS

TEST	PATTERN	NO, PPM (DRY AT 3% O_2)	MIN O_2 %(N/S AVE.)	TEST	PATTERN	NO, PPM (DRY AT 3% O_2)	MIN. O_2 %(N/S AVE.)
1		195-225	3.1	6		235-275	4.2
2		200-245	3.5	7		240-325	4.8
3		205-275	4.6	8		245-300	4.5
4		220-265	4.0	9		255-300	4.7
5		230-265	4.1	● BURNER OUT-OF-SERVICE, AIR REGISTER OPEN			

load capability to 680 MW, with the third row of burners out of service. For continuous operation, however, the actual load limit was set at 630 MW to avoid damage due to boiler vibration, see Figure 6-2, Curve E. As shown by the summary in Table 6-2, this pattern had the lowest emissions of those tested. The range of NO emissions shown in the Table are given for 1 percent excess oxygen over the minimum value which is the smoke threshold. Boiler vibration was not significantly affected by the various patterns tested.

6.1.2 Experimental Burner Modifications

Efforts to increase oil fuel load capability and reduce boiler vibration, continued in the form of an experimental burner program. This program involved the modification of four burners in the unit, and filming at high speed and the effect on flame characteristics. Each of the following modifications were made to a different burner: (a) increased burner throat diameter, (b) addition of an oil gun diffuser plate, (c) extended oil gun, and (d) 10 percent burner tertiary air nozzle and sleeve.

The increased burner throat diameter and diffuser plate modifications did not produce stable flame characteristics, and they were, consequently, rejected. High speed films taken during operation showed the extended oil gun did seem to produce the desired flame characteristics and, subsequently, 32 extended oil guns (10 in.) were obtained for testing. This test could not be completed, however, due to extremely high boiler vibration which resulted before all the extended oil guns could be installed.

The burners were also modified to provide a 10 percent teriary air flow around the oil gun. High speed films indicated that this modification would produce stable flame characteristics, and preparations were made to modify all 32 burners.

The burner tertiary air nozzle and sleeve modification involved manufacture of equipment and taking the unit out-of-service for two months. As a result, this modification was not completed until November 1973. In conjunction with the burner modification, the overfire air ports were increased in size by a factor of two.

Between November 1973 and January 1974, the boiler modifications were thoroughly tested. These tests showed that the 10 percent tertiary air nozzle and sleeve burner modification increased the maximum NOx compliance load to 710 MW (test condition-not acceptable for continuous operation) with boiler vibration at an acceptable level.

The load limiting factor of the 10 percent tertiary air system (710MW) was FD fan capability, due to a high minimum excess oxygen level (5.5 percent) which was required to stay above the smoke threshold, or to maintain a clear stack condition.

In an effort to increase load capability, the amount of tertiary air was decreased to 5 percent. During the next series of tests, which were conducted from February to April 1974, it was found that boiler vibration was still within acceptable limits, the minimum excess oxygen requirement decreased to 4.5 percent and NOx compliance was achieved at a maximum load 730 MW under test conditions.

Although the tertiary air was decreased to 5 percent, the load limiting factor was still a high excess oxygen requirement, and further modification would be required to achieve full load. In June 1974, the unit was again taken out-of-service and, at that time, three 45 deg swirl vanes were installed in the tertiary air nozzle. Testing of this burner configuration showed that the excess oxygen requirement was reduced to 3 percent and NOx complaince was achieved at a maximum load of 750 MW under test conditions. This configuration also precipitated a condition of continuous boiler vibration at load above 400 MW.

The next phase of testing involved a study of the boiler vibration characteristics in an attempt to improve this condition by adjusting existing operating parameters. This was not successful, but the study did suggest a further modification which involved removing the swirl vanes from all but the top row of burners. This was accomplished in October 1974, and testing showed that boiler vibration was reduced to an acceptable level.

The maximum load capability of the unit was significantly limited at that time due to two factors. The first being an increase in the excess oxygen requirment to 4 percent due to removing 75 percent of the tertiary air swirl vanes; and the second was the revised oil fuel NOx emission limit of 225 ppm effective January 1, 1975. Operating within the constraints of acceptable boiler vibration and NOx compliance, the unit is now capable of loads up to 680 MW.

6.2 EFFECTIVENESS OF CONTROLS

As noted in the preceding section there were basically three periods of data taking on unit E. The first was immediately after initial startup. The findings of this period are discussed in the preceding section and are shown in Figure 6-2. To summarize briefly the following conclusions could be drawn:

1. The most effective means of NO_x control was a combination of gas recirculation and staged firing which allowed the unit to operate at a maximum of 79% of its rated capacity without exceeding 250 ppm of NO_x.

2. The use of these controls resulted in excessive boiler vibration and flame instability due to very high burner velocities. This is because the unit, especially the burners, was not designed for either of these control techniques.

3. High levels of excess air were required to avoid smoking when using staged combustion.

Following this initial period the unit was modified in the following way:

a. overfire air ports were enlarged
b. 10% tertiary air nozzles were added
c. ignitors and flame scanners were extended

Another period of data taking following during which the burner pattern for staged combustion was optimized. Maximum NO_x compliance load was increased however, the high excess air levels and boiler vibrations continued to be a problem. Consequently, the unit was modified again. This

time swirl vanes were added, and adjustable tertiary air nozzles were installed. This was the last group of modifications made to the unit to date. The current oil fuel NO_x compliance capability of the unit is 680MW or 85% of its original rated capacity.

The results of the testing and modifications were summarized in figures 6-3 and 6-4. The control techniques which have been effective in reducing NO_x are gas recirculation, staged combustion (interstage air) and load reduction. Overfire air has not been particularly effective in reducing NO_x. This is because excess air had to be increased whenever the overfire air ports were opened in order to maintain a clear stack. It appears that the air entering the furnace was unable to mix properly with the combustion gases.

Figure 6-3 shows the effect of gas recirculation and interstage air with unit load as a parameter. It can be seen that gas recirculation produces a very steep drop in emission, for example the difference in emission from point a to point b represents a decrease of almost 34%.

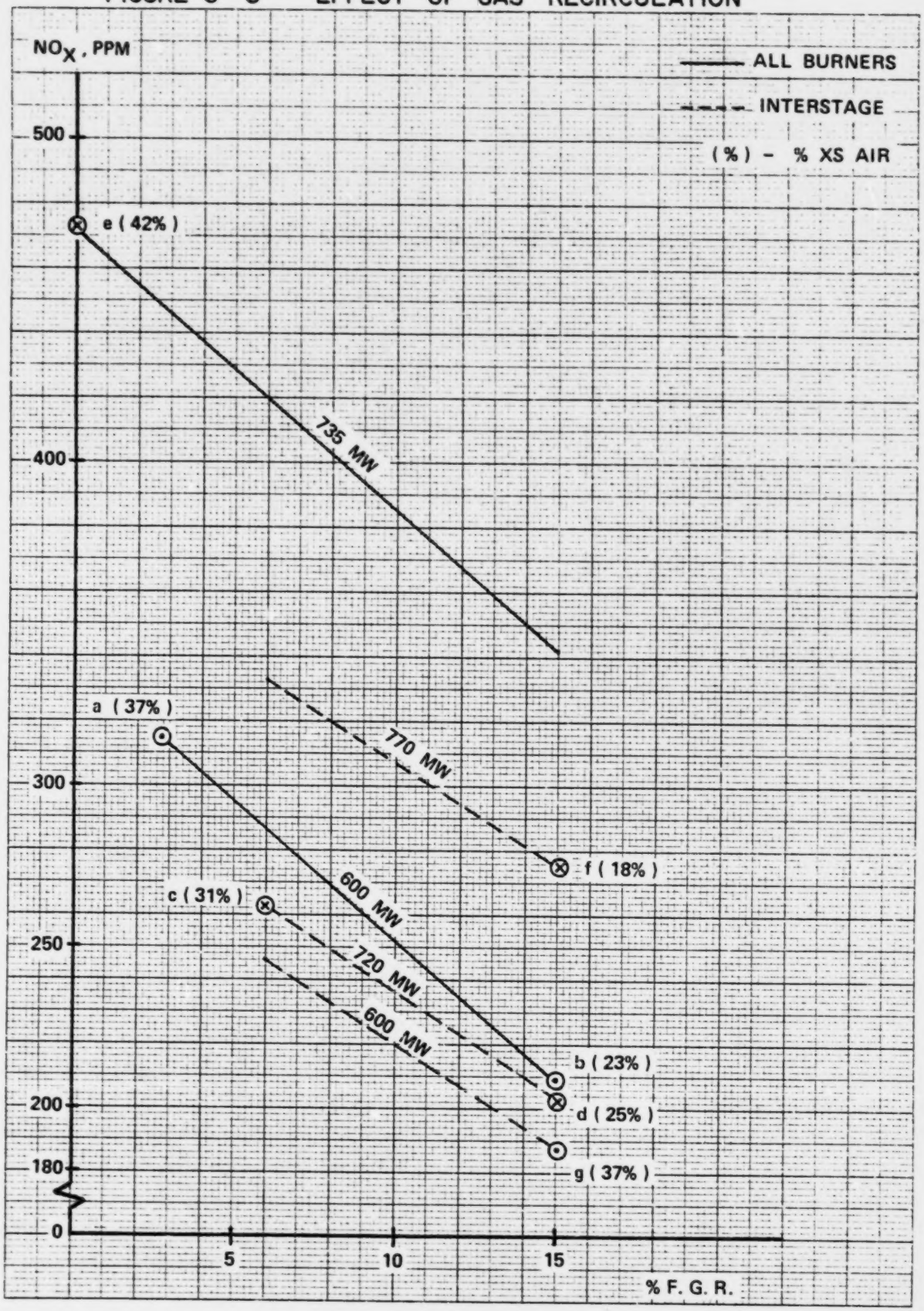
The quantity of gas recirculation which can be used is limited by the capacity of both the gas recirculation and forced draft fans. In particular, because of the high excess air levels which must be maintained when using staged combustion, as well as the increased draft losses resulting from gas recirculation the forced draft fan capacity becomes a limiting factor.

Figure 6-3 shows a steeper slope for line a-b than for line c-d. This is to be expected since for line c-d the interstage firing has already reduced

the thermal NO_x somewhat and consequently, gas recirculation will have a lesser comparative effect.

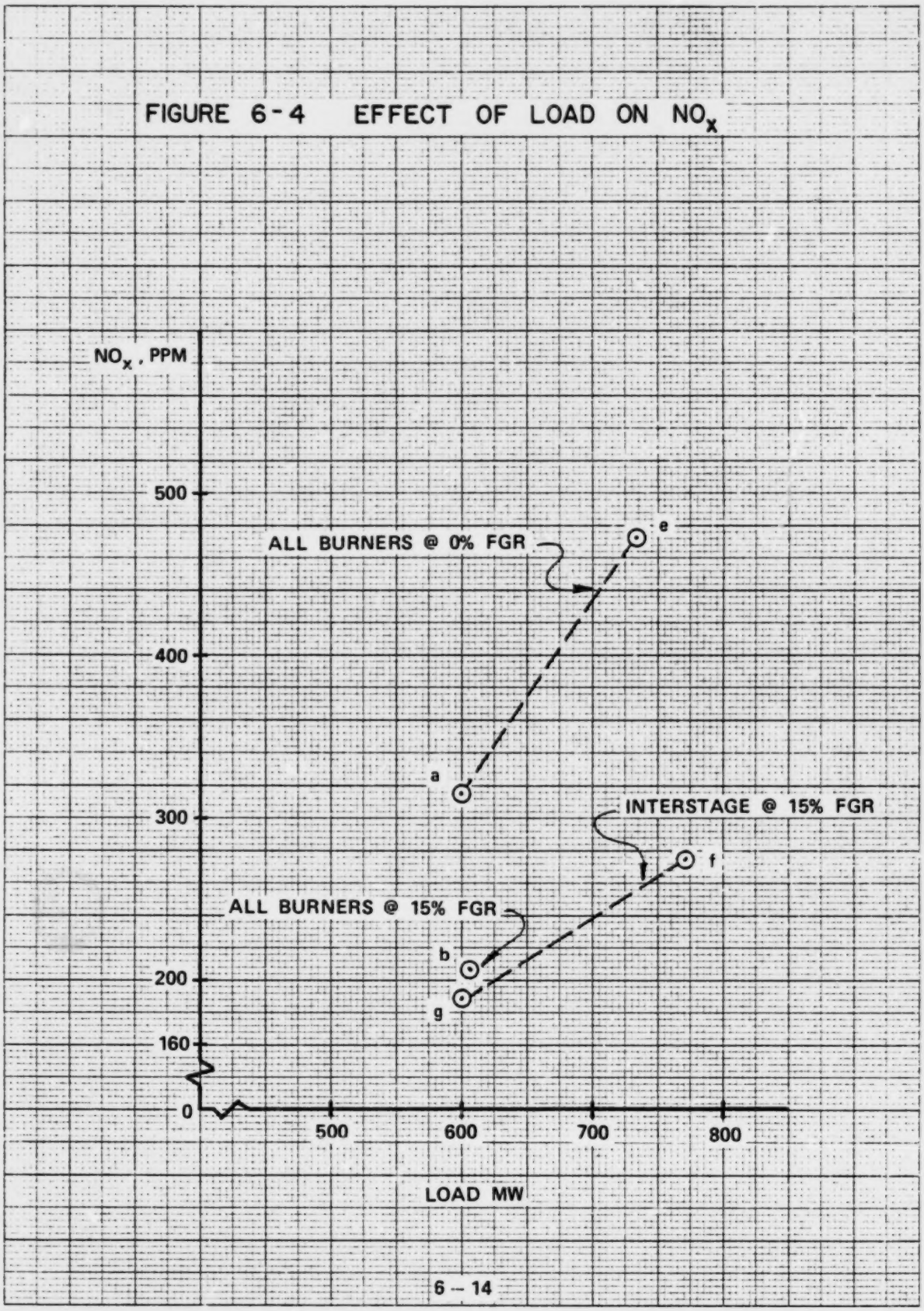
Figure 6-4 shows the effect of reduced load on NO_x emission for the uncontrolled condition as well as for interstage firing. One data point with flue gas recirculation is included. Load reduction is not an acceptable emission control technique however, for this unit there has been no modification which would allow compliance and so the unit has been derated. Line a-e indicates a reduction in emission of 34% for a load reduction of 18% for the unit with no controls. If interstage firing and flue gas recirculation are added however, the effect of load reduction is reduced to 32% reduction in NO_x emission for a load reduction of 22%.

FIGURE 6 - 3 EFFECT OF GAS RECIRCULATION



KEUFFEL & ESSER CO.

FIGURE 6-4 EFFECT OF LOAD ON NO_x



K+E 46 1320
10 X 10 TO ½ INCH
7 X 10 INCHES
KEUFFEL & ESSER CO.

6.3 OPERATIONAL DIFFICULTIES

Modification of Unit E to comply with air quality regulations has introduced severe operational problems. These problems have occurred in two areas:

1. boiler vibrations
2. high excess air requirements

The boiler vibrations have occurred as a result of flame instabilities at the burners. These instabilities are caused by extremely high secondary air and gas flows through the burners which are a result of the addition of gas recirculation. These instabilities are exacerbated by the use of interstage firing which raises the heat output per burner. A whole series of burner modifications have been attempted to alleviate the boiler vibrations however, these have met with limited success. Development work is still continuing in this area.

The other major operating problem at Unit E has been an unusually high excess air requirement whenever off-stoichiometric firing is used. This is especially debilitating because the increased excess air has the effect of increasing NO_x emissions and reducing the effectiveness of the emission controls. In addition, high excess air levels reduce boiler efficiency and increase the unit's fuel usage.

The requirement for very high excess air is especially severe when the overfire air ports are in use but, even with staged combustion excess air must be kept unusually high to avoid a smoky stack. The high excess air requirement also increases velocity through the burners adding to flame

instability and boiler vibration problems. A secondary effect of the high excess air requirement is increased fan power consumption and an attending limitation on unit capability with emission controls in operation due to the capabilities of the fan and its drive.

These operational difficulties have under certain circumstances, caused a greater derating of Unit E than is required to meet NO_x emissions alone. However, none of these problems occur when the unit is operated without emission controls, up to its design rating.

6.4 COST OF MODIFICATIONS

The attached Table 6-3 indicates the cost of the modifications which were made to Unit E. In examining this table it is necessary to keep several points in mind:

1. Costs shown are only for those modifications which were carried out through Foster Wheeler. There may have been modifications performed by others, either in engineering, fabrication or erection, the cost of which is unavailable to Foster Wheeler. For example, the last group of modifications were not installed by Foster Wheeler and consequently, the cost of that installation cannot be included in the table. We do believe however, that the most important modifications were carried out through Foster Wheeler and are included in Table 6-2.

2. The table includes only summary costs for all of the work accomplished under a particular contract between Foster Wheeler and the owner. These totals may include work which was not aimed at NO_x control. However, the scope of work listed in our records includes only the modifications for NO_x control. Furthermore, if other work was included it would have been a very small portion of the total, since the major items in the scope of each group of modifications are easily identified. In any case the amount of effort required to break down these totals on an item by item basis is well beyond what is reasonable for a study effort of this type.

3. The dates listed for each group of modifications are average dates. The actual work was performed over periods of several months.

4. The second group of modifications shows the cost for enlarging the overfire air ports. This cost should be comparable to the cost of adding overfire air ports to a unit which had none. In order to enlarge the ports the waterwall tube sections containing the smaller ports had to be removed which is just what would have to be done if there were no ports to begin with.

5. On Unit E the flue gas recirculation system was added while the unit was in construction. The cost of adding this system is therefore somewhat lower than it would have been if construction were complete. However, the difference in this instance is small because the flue and duct erection work had already been completed by the time the flue gas recirculation system was added. The only savings was in that the contractor's personnel and their equipment were already on the jobsite and able to start work. Therefore, the cost of adding flue gas recirculation to Unit E is basically the same as it would have been if the addition were made after the unit was in operation.

TABLE 6-3

UNIT E MODIFICATION COSTS

APPROXIMATE DATE	SCOPE	COST (Actual)	COST (1978 Dol.)
5/71	Add Gas Recirculation fan, ductwork, mixing device, motor dampers and controls. Includes erection.	$751,575.00	$1,746,000
7/73	Enlarge overfire airports, add tertiary air ports extend ignitors and scanners. Includes erection.	707,670.00	1,319,000
7/74	Add Burner Swirlers. Add adjustable tertiary air ports. Further modification of scanners and ignitors. Does not include erection.	114,000.00	166,800

APPENDIX C
SUMMARY OF NO_x CORRELATION TEST DATA

A listing of the data used in the regression analysis of Section 4 correlating NO_x emissions to degree of control, boiler design and operating variables, and fuel properties is given in Tables C-1 through C-7. Data sources have been referenced in Section 4.2.2. (Detailed process engineering data have been summarized in Section 5, and will not be reproduced here.)

For the NO_x correlation test data, Tables C-1 through C-7, a different table itemizes input data for each specific equipment/fuel classification according to the following scheme:

Table	Equipment/Fuel
C-1	Tangential/Coal
C-2	Opposed Wall/Coal
C-3	Single Wall/Coal
C-4	Opposed Wall/Oil
C-5	Single Wall/Oil
C-6	Opposed Wall/Gas
C-7	Single Wall/Gas

Within each table, the data are divided into sets, with each set representing a single test run. Each set contains four rows of numbers. The first three rows of the data contain information on fuel and boiler variables while the fourth row gives emission levels. Data from the first test on tangential coal-fired boilers have been repeated below. The meaning of each entry is described by its assigned footnote.

DATA KEY

1[a]	1[b]	1[c]	3[d]	1[e]	1.42[f]	113.85[g]	173.1[h]	805.7[i]	64.0[j]	2[k]	0.0[l]
2	1	1	3	1	0.0[m]	0.0[n]	100.0[o]	134.7[p]	5.60[q]	0.0	5.97[r]
3	1	1	3	1	134.7[s]	0.0[t]	0.0[u]	0.0[v]	0.0[w]	20724[x]	1.0[y]
4	1	1	3	1	568.0[z]	0.0[α]	0.0[β]	0.0[γ]	0.0[Δ]	--	--

a -- Row or card number; four rows or cards per test run

b -- Arbitrary number assigned to the boiler

c -- Code number indicating firing type

- 1 -- Tangential (T)
- 2 -- Horizontally Opposed (HO)
- 3 -- Single Wall (SW)

d -- Code number indicating fuel type

- 1 -- Natural Gas
- 2 -- Oil
- 3 -- Coal

e -- Arbitrary assigned number indicating test run

f -- Fuel nitrogen (percent by weight)

g -- Volumetric heat release rate (KW/m^3)

h -- Surface heat release rate (KW/m^2)

i -- Boiler maximum continuous rating MCR (megawatts of heat output)

j -- Number of burners firing

k -- Number of furnaces

l -- Number of division walls

m -- Vertical distance between burners (m); when zero, information was not available

n -- Vertical distance between top burner level and overfire air ports (m); when zero, information was not available

o -- Firing rate (percent)

p -- Furnace stoichiometry (percent)

q -- Excess oxygen (percent by volume)

r -- Coal moisture (percent by weight)

s -- Stoichiometry to active burners (percent)

t -- Flue gas recirculation (percent)

u -- Number of burners on air only

v -- Burner tilt (degrees above or below horizontal position); when zero, information was not available

w -- Overfire air tilt (degrees above or below horizontal position); when zero, information was not available

x -- Heating value of the fuel (kJ/kg) on a dry basis for coal and oil, MJ/m^3 for natural gas

y -- Code number indirecting the type of test and type of NO_x controls applied

1.0 -- Baseline and low excess air tests
2.0 -- Off stoichiometric combustion test with burners out of service
2.1 -- Off stoichiometric combustion test with biased burner firing
3.0 -- Off stoichiometric combustion test with overfire air
4.0 -- Burners out of service and overfire air
5.0 -- Flue gas recirculation
6.0 -- Burners out of service and flue gas recirculation
7.0 -- Overfire air and flue gas recirculation
8.0 -- Burners out of service, overfire air, and flue gas recirculation

z -- NO_x emissions (ppm dry @ 3% O_2)

α -- SO_2 emissions (ppm dry @ 3% O_2); if zero, data not available

β -- SO_3 emissions (ppm dry @ 3% O_2); if zero, data not available

γ -- CO emissions (ppm dry @ 3% O_2); if zero, data not available

Δ -- Particulate emissions (ng/J); if zero, data not available

TABLE C-1. NO_x CONTROL TEST DATA FROM TANGENTIAL COAL-FIRED BOILERS

1	1	1	3	1	1.42000+00	1.17990+02	1.79465+02	8.35050+05	6.40000+01	2.00000+00	0.00000
2	1	1	3	1	0.00000	0.00000	1.00000+02	1.34700+02	5.60000+00	0.00000	5.97000+00
3	1	1	3	1	1.34700+02	0.00000	0.00000	0.00000	0.00000	2.97238+04	1.00000+00
4	1	1	3	1	5.68000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	1	1	3	2	1.42000+00	1.17990+02	1.79465+02	8.35050+05	6.40000+01	2.00000+00	0.00000
2	1	1	3	2	0.00000	0.00000	1.00000+02	1.15800+02	3.00000+00	0.00000	5.97000+00
3	1	1	3	2	1.15800+02	0.00000	0.00000	0.00000	0.00000	2.97238+04	1.00000+00
4	1	1	3	2	4.14000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	1	1	3	3	1.42000+00	9.43920+01	1.43565+02	8.35050+05	6.40000+01	2.00000+00	0.00000
2	1	1	3	3	0.00000	0.00000	8.00000+01	1.22000+02	3.90000+00	0.00000	5.97000+00
3	1	1	3	3	1.22000+02	0.00000	0.00000	0.00000	0.00000	2.97238+04	1.00000+00
4	1	1	3	3	4.18000+02	0.00000	0.00000	1.20000+01	0.00000	0.00000	0.00000
1	1	1	3	4	1.42000+00	9.43920+01	1.43565+02	8.35050+05	6.40000+01	2.00000+00	0.00000
2	1	1	3	4	0.00000	0.00000	8.00000+01	1.11000+02	2.20000+00	0.00000	5.97000+00
3	1	1	3	4	1.11000+02	0.00000	0.00000	0.00000	0.00000	2.97238+04	1.00000+00
4	1	1	3	4	3.01000+02	0.00000	0.00000	6.70000+01	0.00000	0.00000	0.00000
1	2	1	3	5	1.30000+00	1.29996+02	2.37761+02	1.38589+06	4.00000+01	2.00000+00	0.00000
2	2	1	3	5	0.00000	0.00000	8.78000+01	1.17300+02	3.20000+00	0.00000	8.50000+00
3	2	1	3	5	1.17300+02	0.00000	0.00000	-3.00000+01	0.00000	2.84656+04	1.00000+00
4	2	1	3	5	4.05000+02	0.00000	0.00000	2.60000+01	0.00000	0.00000	0.00000
1	2	1	3	6	1.30000+00	1.29996+02	2.37761+02	1.38589+06	4.00000+01	2.00000+00	0.00000
2	2	1	3	6	0.00000	0.00000	8.78000+01	1.09700+02	1.90000+00	0.00000	9.14000+00
3	2	1	3	6	1.09700+02	0.00000	0.00000	-3.00000+01	0.00000	2.56230+04	1.00000+00
4	2	1	3	6	3.64000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	2	1	3	7	1.30000+00	1.27616+02	2.33440+02	1.38589+06	3.20000+01	2.00000+00	0.00000
2	2	1	3	7	0.00000	0.00000	8.62000+01	1.18100+02	3.30000+00	0.00000	8.29000+00
3	2	1	3	7	9.40000+01	0.00000	8.00000+00	-3.00000+01	0.00000	2.75709+04	2.00000+00
4	2	1	3	7	2.55000+02	0.00000	0.00000	4.20000+01	0.00000	0.00000	0.00000
1	2	1	3	8	1.30000+00	1.29271+02	2.36405+02	1.38589+06	3.20000+01	2.00000+00	0.00000
2	2	1	3	8	0.00000	0.00000	8.73000+01	1.10800+02	2.10000+00	0.00000	6.88000+00
3	2	1	3	8	8.90000+01	0.00000	8.00000+00	-3.00000+01	0.00000	2.84190+04	2.00000+00
4	2	1	3	8	1.95000+02	0.00000	0.00000	5.30000+01	0.00000	0.00000	0.00000
1	2	1	3	9	1.30000+00	1.07640+02	1.96878+02	1.38589+06	2.40000+01	2.00000+00	0.00000
2	2	1	3	9	0.00000	0.00000	7.27000+01	1.07000+02	1.50000+00	0.00000	7.48000+00
3	2	1	3	9	1.07000+02	0.00000	0.00000	1.00000+01	0.00000	2.52805+04	1.00000+00
4	2	1	3	9	2.74000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	2	1	3	10	1.30000+00	1.06916+02	1.95522+02	1.38589+06	3.20000+01	2.00000+00	0.00000
2	2	1	3	10	0.00000	0.00000	7.22000+01	1.13100+02	2.50000+00	0.00000	6.26000+00
3	2	1	3	10	8.48000+01	0.00000	8.00000+00	1.00000+01	0.00000	2.54762+04	2.00000+00
4	2	1	3	10	1.52000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	3	1	3	11	1.20000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	11	1.31978+00	2.36220+00	1.00000+02	1.25000+02	5.02000+00	0.00000	7.40000+00
3	3	1	3	11	1.25000+02	0.00000	0.00000	0.00000	0.00000	2.75126+04	1.00000+00
4	3	1	3	11	5.69100+02	1.24700+03	0.00000	2.83000+01	0.00000	0.00000	0.00000
1	3	1	3	12	1.30000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	12	1.31978+00	2.36220+00	1.00000+02	1.17900+02	3.90000+00	0.00000	8.80000+00
3	3	1	3	12	1.17900+02	0.00000	0.00000	3.00000+00	0.00000	2.70932+04	1.00000+00
4	3	1	3	12	4.23400+02	1.40700+03	0.00000	2.66000+01	1.84900+02	4.54400+00	0.00000
1	3	1	3	13	1.20000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	13	1.31978+00	2.36220+00	1.00000+02	1.07200+02	2.26000+00	0.00000	7.00000+00
3	3	1	3	13	1.07200+02	0.00000	0.00000	0.00000	0.00000	2.71165+04	1.00000+00
4	3	1	3	13	3.06000+02	1.22900+03	0.00000	1.31100+02	0.00000	0.00000	0.00000
1	3	1	3	14	1.20000+00	1.06087+02	6.00634+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	14	1.31978+00	2.36220+00	7.71000+01	1.09200+02	2.40000+00	0.00000	9.80000+00
3	3	1	3	14	1.09200+02	0.00000	0.00000	8.00000+00	0.00000	2.70466+04	1.00000+00
4	3	1	3	14	3.67700+02	1.40100+03	0.00000	3.34000+01	0.00000	0.00000	0.00000
1	3	1	3	15	1.20000+00	1.03396+02	5.85177+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	15	1.31978+00	2.36220+00	7.51000+01	1.29300+02	4.76000+00	0.00000	9.00000+00
3	3	1	3	15	9.73000+01	0.00000	4.00000+00	1.00000+01	0.00000	2.70723+04	2.00000+00
4	3	1	3	15	2.83700+02	1.34200+03	0.00000	2.66000+01	0.00000	0.00000	0.00000
1	3	1	3	16	1.20000+00	7.18290+01	4.06627+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	16	1.31978+00	2.36220+00	5.22000+01	1.51300+02	7.90000+00	0.00000	7.60000+00
3	3	1	3	16	1.51300+02	0.00000	0.00000	7.00000+00	0.00000	2.72563+04	1.00000+00
4	3	1	3	16	6.15400+02	1.40900+03	0.00000	6.86000+00	0.00000	0.00000	0.00000
1	3	1	3	17	1.20000+00	7.34850+01	4.16091+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	17	1.31978+00	2.36220+00	5.34000+01	1.30600+02	5.59000+00	0.00000	8.80000+00
3	3	1	3	17	1.30600+02	0.00000	0.00000	3.00000+00	0.00000	2.70723+04	1.00000+00
4	3	1	3	17	5.40900+02	1.97000+03	0.00000	2.06000+01	0.00000	0.00000	0.00000
1	3	1	3	18	1.10000+00	7.08975+01	4.01264+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	18	1.31978+00	2.36220+00	5.15000+01	1.28000+02	5.30000+00	0.00000	9.50000+00
3	3	1	3	18	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.67647+04	1.00000+00
4	3	1	3	18	4.59400+02	2.01300+03	0.00000	2.55400+02	0.00000	0.00000	0.00000
1	3	1	3	19	1.10000+00	1.05467+02	5.96849+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	19	1.31978+00	2.36220+00	7.66000+01	1.26300+02	4.20000+00	0.00000	9.40000+00
3	3	1	3	19	9.47000+01	0.00000	4.00000+00	-5.00000+00	0.00000	2.70000+04	2.00000+00
4	3	1	3	19	2.44300+02	1.95200+03	0.00000	2.31000+01	0.00000	0.00000	0.00000
1	3	1	3	20	1.10000+00	7.08975+01	4.01264+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	20	1.31978+00	2.36220+00	5.15000+01	1.49300+02	6.90000+00	0.00000	1.19000+01
3	3	1	3	20	1.12500+02	0.00000	4.00000+00	0.00000	0.00000	2.55321+04	2.00000+00
4	3	1	3	20	4.45700+02	1.59500+03	0.00000	2.49000+01	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	3	1	3	21	1.10000+00	1.45107+02	8.21140+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	21	1.31978+00	2.36220+00	1.05400+02	1.20000+02	4.50000+00	0.00000	5.20000+00
3	3	1	3	21	1.20000+02	0.00000	0.00000	-6.00000+00	0.00000	2.84470+04	1.00000+00
4	3	1	3	21	3.69400+02	2.14300+03	0.00000	2.06000+01	0.00000	0.00000	0.00000
1	3	1	3	22	1.10000+00	1.46452+02	8.29026+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	22	1.31978+00	2.36220+00	1.06400+02	1.16000+02	3.90000+00	0.00000	6.50000+00
3	3	1	3	22	1.16000+02	0.00000	0.00000	-6.00000+00	0.00000	2.66319+04	1.00000+00
4	3	1	3	22	3.35100+02	2.19800+03	0.00000	1.97000+01	0.00000	0.00000	0.00000
1	3	1	3	23	1.10000+00	1.49454+02	8.46061+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	23	1.31978+00	2.36220+00	1.08600+02	1.07000+02	2.40000+00	0.00000	9.10000+00
3	3	1	3	23	1.07000+02	0.00000	0.00000	-3.00000+00	0.00000	2.68672+04	1.00000+00
4	3	1	3	23	2.82900+02	2.29500+03	0.00000	1.08900+02	0.00000	0.00000	0.00000
1	3	1	3	24	1.00000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	24	1.31978+00	2.36220+00	1.00000+02	1.17500+02	4.40000+00	0.00000	7.50000+00
3	3	1	3	24	9.40000+01	0.00000	0.00000	-5.00000+00	0.00000	2.85635+04	3.00000+00
4	3	1	3	24	2.90600+02	2.10000+03	0.00000	2.14000+01	0.00000	0.00000	0.00000
1	3	1	3	25	1.00000+00	1.41070+02	7.98742+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	25	1.31978+00	2.36220+00	1.02500+02	1.13800+02	3.80000+00	0.00000	7.10000+00
3	3	1	3	25	9.10000+01	0.00000	0.00000	-4.00000+00	0.00000	2.78645+04	3.00000+00
4	3	1	3	25	2.90600+02	1.44000+03	0.00000	2.23000+01	0.00000	9.37000+00	0.00000
1	3	1	3	26	1.00000+00	1.41795+02	8.02528+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	3	1	3	26	1.31978+00	2.36220+00	1.03000+02	1.16300+02	4.40000+00	0.00000	8.10000+00
3	3	1	3	26	9.30000+01	0.00000	0.00000	-2.10000+01	3.00000+01	2.83095+04	3.00000+00
4	3	1	3	26	2.44300+02	2.77700+03	0.00000	4.20000+01	0.00000	0.00000	0.00000
1	3	1	3	27	1.10000+00	1.14885+02	6.45114+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	27	1.31978+00	2.36220+00	8.28000+01	1.14000+02	4.70000+00	0.00000	7.40000+00
3	3	1	3	27	1.14000+02	0.00000	0.00000	-5.00000+00	0.00000	2.77037+04	1.00000+00
4	3	1	3	27	2.95700+02	1.62200+03	0.00000	2.40000+01	0.00000	0.00000	0.00000
1	3	1	3	28	1.40000+00	1.16644+02	6.59940+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	28	1.31978+00	2.36220+00	8.47000+01	1.13300+02	4.50000+00	0.00000	8.00000+00
3	3	1	3	28	8.48000+01	0.00000	0.00000	-4.00000+00	0.00000	2.81441+04	3.00000+00
4	3	1	3	28	1.96300+02	2.05500+03	0.00000	4.11000+01	0.00000	0.00000	0.00000
1	3	1	3	29	9.00000-01	1.08158+02	6.12306+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	29	1.31978+00	2.36220+00	7.86000+01	1.27000+02	5.36000+00	0.00000	1.01000+01
3	3	1	3	29	1.27000+02	0.00000	0.00000	3.00000+00	0.00000	2.52083+04	1.00000+00
4	3	1	3	29	3.80600+02	3.15300+03	0.00000	2.31000+01	0.00000	0.00000	0.00000
1	3	1	3	30	1.00000+00	1.05259+02	5.96218+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	3	1	3	30	1.31978+00	2.36220+00	7.65000+01	1.13000+02	2.95000+00	0.00000	9.80000+00
3	3	1	3	30	1.13000+02	0.00000	0.00000	6.00000+00	0.00000	2.56067+04	1.00000+00
4	3	1	3	30	2.87100+02	3.10400+03	0.00000	3.22300+02	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	3	1	3	31	1.00000+00	6.92415+01	3.91800+01	3.23472+05	8.00000+00	1.00000+00	0.00000
2	3	1	3	31	1.31978+00	2.36220+00	5.03000+01	1.54000+02	6.70000+00	0.00000	9.60000+00
3	3	1	3	31	8.80000+01	0.00000	0.00000	-1.50000+01	-1.00000+01	2.86567+04	4.00000+00
4	3	1	3	31	2.68300+02	2.07400+03	0.00000	2.14000+01	0.00000	0.00000	0.00000
1	4	1	3	32	1.39000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	32	0.00000	0.00000	1.00000+02	1.34000+02	5.40000+00	0.00000	1.32700+01
3	4	1	3	32	1.34000+02	0.00000	0.00000	1.00000+01	1.00000+01	2.74288+04	1.00000+00
4	4	1	3	32	4.16000+02	0.00000	0.00000	0.00000	0.00000	4.27000+00	0.00000
1	4	1	3	33	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	33	0.00000	0.00000	1.00000+02	1.29000+02	4.90000+00	0.00000	1.28600+01
3	4	1	3	33	1.29000+02	0.00000	0.00000	1.00000+01	0.00000	2.85891+04	1.00000+00
4	4	1	3	33	3.66000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	1	3	34	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	34	0.00000	0.00000	1.00000+02	1.23000+02	4.00000+00	0.00000	1.28600+01
3	4	1	3	34	1.23000+02	0.00000	0.00000	1.00000+01	0.00000	2.85891+04	1.00000+00
4	4	1	3	34	3.35000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	1	3	35	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	35	0.00000	0.00000	1.00000+02	1.23000+02	4.00000+00	0.00000	1.28600+01
3	4	1	3	35	1.18800+02	0.00000	0.00000	1.00000+01	1.00000+01	2.85891+04	3.00000+00
4	4	1	3	35	3.32000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	1	3	36	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	36	0.00000	0.00000	1.00000+02	1.17000+02	3.80000+00	0.00000	1.28600+01
3	4	1	3	36	1.05500+02	0.00000	0.00000	1.00000+01	1.00000+01	2.85891+04	3.00000+00
4	4	1	3	36	2.93000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	1	3	37	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	37	0.00000	0.00000	1.00000+02	1.26000+02	4.60000+00	0.00000	1.35400+01
3	4	1	3	37	1.10300+02	0.00000	0.00000	1.10000+01	1.00000+01	2.90528+04	3.00000+00
4	4	1	3	37	3.46000+02	0.00000	0.00000	0.00000	0.00000	6.85000+00	0.00000
1	4	1	3	38	1.39000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	38	0.00000	0.00000	1.00000+02	1.25000+02	4.40000+00	0.00000	1.32700+01
3	4	1	3	38	1.09400+02	0.00000	0.00000	1.20000+01	1.00000+01	2.74288+04	3.00000+00
4	4	1	3	38	3.49000+02	0.00000	0.00000	0.00000	0.00000	6.26000+00	0.00000
1	4	1	3	39	1.38000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	39	0.00000	0.00000	1.00000+02	1.19000+02	3.70000+00	0.00000	1.28100+01
3	4	1	3	39	1.04100+02	0.00000	0.00000	1.00000+01	1.00000+01	2.92718+04	3.00000+00
4	4	1	3	39	2.80000+02	0.00000	0.00000	0.00000	0.00000	2.87000+00	0.00000
1	4	1	3	40	1.40000+00	1.34550+02	0.00000	1.77324+06	5.60000+01	2.00000+00	0.00000
2	4	1	3	40	0.00000	0.00000	1.00000+02	1.32000+02	5.20000+00	0.00000	1.28600+01
3	4	1	3	40	1.32000+02	0.00000	0.00000	1.00000+01	1.00000+01	2.85891+04	1.00000+00
4	4	1	3	40	3.78000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	4	1	3	41	1.40000+00	1.34550+02	0.00000	1.77324+06	4.80000+01	2.00000+00	0.00000
2	4	1	3	41	0.00000	0.00000	1.00000+02	1.30000+02	5.00000+00	0.00000	1.28600+01
3	4	1	3	41	1.11400+02	0.00000	8.00000+00	1.00000+01	1.00000+01	2.85891+04	2.00000+00
4	4	1	3	41	3.18000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	1	3	42	1.40000+00	1.34550+02	0.00000	1.77324+06	4.80000+01	2.00000+00	0.00000
2	4	1	3	42	0.00000	0.00000	1.00000+02	1.20000+02	3.60000+00	0.00000	1.28600+01
3	4	1	3	42	1.02900+02	0.00000	8.00000+00	1.00000+01	1.00000+01	2.85891+04	2.00000+00
4	4	1	3	42	2.59000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	43	1.00000+00	1.40656+02	1.41767+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	43	0.00000	0.00000	9.71000+01	1.22000+02	3.90000+00	0.00000	3.18600+01
3	5	1	3	43	1.22000+02	0.00000	0.00000	-1.50000+01	0.00000	2.76781+04	1.00000+00
4	5	1	3	43	3.89000+02	0.00000	0.00000	0.00000	0.00000	3.11000+00	0.00000
1	5	1	3	44	1.00000+00	1.40656+02	1.41767+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	44	0.00000	0.00000	9.71000+01	1.21000+02	3.80000+00	0.00000	3.15500+01
3	5	1	3	44	1.18600+02	0.00000	0.00000	-1.60000+01	0.00000	2.76548+04	3.00000+00
4	5	1	3	44	3.73000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	45	1.00000+00	1.38690+02	1.39717+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	45	0.00000	0.00000	9.57000+01	1.25000+02	4.10000+00	0.00000	3.15500+01
3	5	1	3	45	1.19000+02	0.00000	0.00000	-1.70000+01	-1.50000+01	2.76548+04	3.00000+00
4	5	1	3	45	3.55000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	46	1.00000+00	1.38690+02	1.39717+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	46	0.00000	0.00000	9.57000+01	1.25500+02	4.20000+00	0.00000	3.15500+01
3	5	1	3	46	1.13600+02	0.00000	0.00000	-1.70000+01	-1.50000+01	2.76548+04	3.00000+00
4	5	1	3	46	3.06000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	47	1.00000+00	1.37758+02	1.38834+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	47	0.00000	0.00000	9.51000+01	1.18000+02	3.70000+00	0.00000	3.15500+01
3	5	1	3	47	1.02600+02	0.00000	0.00000	-1.70000+01	-1.50000+01	2.76548+04	3.00000+00
4	5	1	3	47	2.61000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	48	1.00000+00	1.37344+02	1.38392+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	48	0.00000	0.00000	9.48000+01	1.17000+02	3.50000+00	0.00000	3.15500+01
3	5	1	3	48	9.75000+01	0.00000	0.00000	-1.80000+01	-1.50000+01	2.76548+04	3.00000+00
4	5	1	3	48	2.66000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	49	1.00000+00	1.33722+02	1.34733+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	49	0.00000	0.00000	9.23000+01	1.21000+02	3.80000+00	0.00000	3.15500+01
3	5	1	3	49	1.21000+02	0.00000	0.00000	-2.00000+01	0.00000	2.76548+04	1.00000+00
4	5	1	3	49	4.28000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	1	3	50	1.00000+00	1.33722+02	1.34733+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	50	0.00000	0.00000	9.23000+01	1.22000+02	3.90000+00	0.00000	3.15500+01
3	5	1	3	50	1.16200+02	0.00000	0.00000	-2.00000+01	0.00000	2.76548+04	3.00000+00
4	5	1	3	50	3.62000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	5	1	3	51	1.00000+00	1.32894+02	1.33881+02	9.76276+05	2.00000+01	1.00000+00	0.00000
2	5	1	3	51	0.00000	0.00000	9.17000+01	1.21000+02	3.80000+00	0.00000	3.15700+01
3	5	1	3	51	1.10000+02	0.00000	0.00000	-2.00000+01	0.00000	2.76594+04	3.00000+00
4	5	1	3	51	2.45000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	1	3	52	1.33000+00	9.81180+01	1.55111+02	1.53151+06	3.20000+01	2.00000+00	0.00000
2	6	1	3	52	0.00000	0.00000	5.24000+01	1.44000+02	6.50000+00	0.00000	9.14000+00
3	6	1	3	52	1.44000+02	0.00000	0.00000	0.00000	0.00000	2.98240+04	1.00000+00
4	6	1	3	52	5.44000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	1	3	53	1.33000+00	1.02258+02	1.61641+02	1.53151+06	3.20000+01	2.00000+00	0.00000
2	6	1	3	53	0.00000	0.00000	5.46000+01	1.42000+02	6.30000+00	0.00000	9.14000+00
3	6	1	3	53	1.42000+02	0.00000	0.00000	0.00000	0.00000	2.98240+04	1.00000+00
4	6	1	3	53	5.15000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	1	3	54	8.00000-01	1.39311+02	2.37509+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	54	1.88062+00	1.44780+00	1.11200+02	1.37800+02	6.20000+00	0.00000	8.10000+00
3	7	1	3	54	1.37800+02	0.00000	0.00000	1.50000+01	0.00000	2.57745+04	1.00000+00
4	7	1	3	54	6.15400+02	3.20600+02	0.00000	2.31000+01	0.00000	0.00000	0.00000
1	7	1	3	55	8.00000-01	1.38172+02	2.35585+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	55	1.88062+00	1.44780+00	1.10300+02	1.30100+02	5.30000+00	0.00000	7.70000+00
3	7	1	3	55	1.30100+02	0.00000	0.00000	1.30000+01	0.00000	2.85705+04	1.00000+00
4	7	1	3	55	5.74300+02	3.39400+02	0.00000	2.14000+01	0.00000	0.00000	0.00000
1	7	1	3	56	1.20000+00	1.39311+02	2.37509+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	56	1.88062+00	1.44780+00	1.11200+02	1.24800+02	4.60000+00	0.00000	7.30000+00
3	7	1	3	56	1.24800+02	0.00000	0.00000	1.10000+01	0.00000	2.79414+04	1.00000+00
4	7	1	3	56	4.56900+02	3.32600+02	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	1	3	57	9.00000-01	1.37758+02	2.34954+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	57	1.88062+00	1.44780+00	1.10000+02	1.16400+02	3.40000+00	0.00000	8.40000+00
3	7	1	3	57	1.16400+02	0.00000	0.00000	1.40000+01	0.00000	2.51920+04	1.00000+00
4	7	1	3	57	4.08000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	1	3	58	1.00000+00	9.45266+01	1.61231+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	58	1.88062+00	1.44780+00	7.54800+01	1.50000+02	7.10000+00	0.00000	8.80000+00
3	7	1	3	58	1.50000+02	0.00000	0.00000	6.00000+00	0.00000	2.82233+04	1.00000+00
4	7	1	3	58	6.29100+02	2.79400+02	0.00000	1.46000+01	0.00000	0.00000	0.00000
1	7	1	3	59	1.30000+00	9.38020+01	1.59969+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	59	1.88062+00	1.44780+00	7.49000+01	1.26400+02	4.60000+00	0.00000	9.00000+00
3	7	1	3	59	1.26400+02	0.00000	0.00000	6.00000+00	0.00000	2.82909+04	1.00000+00
4	7	1	3	59	4.06300+02	2.02300+02	0.00000	1.29000+01	0.00000	0.00000	0.00000
1	7	1	3	60	1.20000+00	7.51203+01	1.28108+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	60	1.88062+00	1.44780+00	5.99800+01	1.46600+02	6.90000+00	0.00000	7.00000+00
3	7	1	3	60	1.46600+02	0.00000	0.00000	1.30000+01	0.00000	2.88687+04	1.00000+00
4	7	1	3	60	5.73400+02	4.06300+02	0.00000	1.37000+01	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	7	1	3	61	1.30000+00	7.43751+01	1.26846+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	61	1.88062+00	1.44780+00	5.93900+01	1.31100+02	5.20000+00	0.00000	6.70000+00
3	7	1	3	61	1.31100+02	0.00000	0.00000	1.10000+01	0.00000	2.89200+04	1.00000+00
4	7	1	3	61	4.91100+02	3.11100+02	0.00000	1.37000+01	0.00000	0.00000	0.00000
1	7	1	3	62	1.30000+00	7.54825+01	1.28739+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	62	1.88062+00	1.44780+00	6.02700+01	1.27900+02	4.80000+00	0.00000	8.00000+00
3	7	1	3	62	1.27900+02	0.00000	0.00000	1.30000+01	0.00000	2.86870+04	1.00000+00
4	7	1	3	62	4.02900+02	3.84000+02	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	1	3	63	1.30000+00	7.47477+01	1.27477+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	63	1.88062+00	1.44780+00	5.96900+01	1.24300+02	4.30000+00	0.00000	9.00000+00
3	7	1	3	63	1.24300+02	0.00000	0.00000	1.20000+01	0.00000	2.82676+04	1.00000+00
4	7	1	3	63	3.75400+02	3.82300+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	64	1.30000+00	7.95087+01	1.35616+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	64	1.88062+00	1.44780+00	6.34900+01	1.23900+02	4.10000+00	0.00000	7.60000+00
3	7	1	3	64	9.97000+01	0.00000	0.00000	0.00000	3.00000+01	2.83188+04	3.00000+00
4	7	1	3	64	2.65700+02	3.80600+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	65	1.30000+00	7.98709+01	1.36215+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	65	1.88062+00	1.44780+00	6.37800+01	1.22800+02	4.00000+00	0.00000	8.50000+00
3	7	1	3	65	9.73000+01	0.00000	0.00000	0.00000	3.00000+01	2.84773+04	3.00000+00
4	7	1	3	65	2.28000+02	3.45400+02	0.00000	5.40000+01	0.00000	0.00000	0.00000
1	7	1	3	66	1.30000+00	1.36206+02	2.32399+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	66	1.88062+00	1.44780+00	1.08800+02	1.28200+02	4.70000+00	0.00000	9.40000+00
3	7	1	3	66	1.20200+02	0.00000	0.00000	-1.00000+01	0.00000	2.71725+04	3.00000+00
4	7	1	3	66	4.39700+02	3.87400+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	67	1.20000+00	1.36206+02	2.32399+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	67	1.88062+00	1.44780+00	1.08800+02	1.26200+02	4.50000+00	0.00000	8.30000+00
3	7	1	3	67	1.11600+02	0.00000	0.00000	-1.00000+01	0.00000	2.79414+04	3.00000+00
4	7	1	3	67	3.96000+02	3.17100+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	68	1.20000+00	1.35585+02	2.31326+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	68	1.88062+00	1.44780+00	1.08300+02	1.25500+02	4.40000+00	0.00000	8.30000+00
3	7	1	3	68	1.07100+02	0.00000	0.00000	-1.40000+01	0.00000	2.68929+04	3.00000+00
4	7	1	3	68	3.68600+02	3.44600+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	69	1.30000+00	1.35565+02	2.31326+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	69	1.88062+00	1.44780+00	1.08300+02	1.25500+02	4.30000+00	0.00000	8.70000+00
3	7	1	3	69	1.05400+02	0.00000	0.00000	-1.20000+01	0.00000	2.76385+04	3.00000+00
4	7	1	3	69	3.57400+02	3.56600+02	0.00000	1.28000+01	0.00000	0.00000	0.00000
1	7	1	3	70	1.30000+00	1.35585+02	2.31326+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	70	1.88062+00	1.44780+00	1.08300+02	1.22000+02	3.90000+00	0.00000	8.10000+00
3	7	1	3	70	9.92000+01	0.00000	0.00000	-2.00000+01	0.00000	2.76152+04	3.00000+00
4	7	1	3	70	3.13700+02	3.40300+02	0.00000	1.30000+01	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	7	1	3	71	1.20000+00	1.37344+02	2.34323+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	71	1.88062+00	1.44780+00	1.09700+02	1.19800+02	3.60000+00	0.00000	8.00000+00
3	7	1	3	71	1.07100+02	0.00000	4.00000+00	6.00000+00	0.00000	2.83608+04	2.00000+00
4	7	1	3	71	2.91400+02	3.58300+02	0.00000	4.80000+01	0.00000	0.00000	0.00000
1	7	1	3	72	1.30000+00	7.98709+01	1.36215+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	72	1.88062+00	1.44780+00	6.37800+01	1.22600+02	4.00000+00	0.00000	8.30000+00
3	7	1	3	72	1.06500+02	0.00000	4.00000+00	6.00000+00	0.00000	2.82676+04	2.00000+00
4	7	1	3	72	3.11100+02	3.07700+02	0.00000	1.37000+01	0.00000	0.00000	0.00000
1	7	1	3	73	1.30000+00	1.09192+02	1.86215+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	73	1.88062+00	1.44780+00	8.71900+01	1.26900+02	4.80000+00	0.00000	8.10000+00
3	7	1	3	73	1.26900+02	0.00000	0.00000	0.00000	0.00000	2.77317+04	1.00000+00
4	7	1	3	73	5.67400+02	3.73700+02	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	1	3	74	1.30000+00	1.09192+02	1.86215+02	1.13098+06	2.00000+01	1.00000+00	0.00000
2	7	1	3	74	1.88062+00	1.44780+00	8.71900+01	1.21300+02	4.00000+00	0.00000	8.40000+00
3	7	1	3	74	1.21300+02	0.00000	0.00000	0.00000	0.00000	2.85006+04	1.00000+00
4	7	1	3	74	5.07400+02	3.47100+02	0.00000	1.20000+01	0.00000	0.00000	0.00000
1	7	1	3	75	1.30000+00	1.08054+02	1.84354+02	1.13098+06	1.60000+01	1.00000+00	0.00000
2	7	1	3	75	1.88062+00	1.44780+00	8.63100+01	1.29300+02	4.90000+00	0.00000	8.10000+00
3	7	1	3	75	1.09100+02	0.00000	4.00000+00	7.00000+00	0.00000	2.77084+04	2.00000+00
4	7	1	3	75	3.60900+02	3.48000+02	0.00000	1.46000+01	0.00000	0.00000	0.00000
1	8	1	3	76	6.00000-01	1.16024+02	2.09717+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	8	1	3	76	1.67640+00	1.44780+00	9.19000+01	1.17800+02	4.30000+00	0.00000	2.51000+01
3	8	1	3	76	1.17800+02	0.00000	0.00000	-4.00000+00	0.00000	1.97607+04	1.00000+00
4	8	1	3	76	5.57100+02	9.90900+02	0.00000	1.37000+01	0.00000	0.00000	0.00000
1	8	1	3	77	7.00000-01	1.13643+02	2.05395+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	8	1	3	77	1.67640+00	1.44780+00	9.00000+01	1.14300+02	3.50000+00	0.00000	2.46000+01
3	8	1	3	77	1.14300+02	0.00000	0.00000	-4.00000+00	0.00000	1.96000+04	1.00000+00
4	8	1	3	77	5.36600+02	1.02600+03	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	1	3	78	7.00000-01	1.11883+02	2.02178+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	8	1	3	78	1.67640+00	1.44780+00	8.86000+01	1.20900+02	4.30000+00	0.00000	2.79000+01
3	8	1	3	78	1.20900+02	0.00000	0.00000	-4.00000+00	0.00000	1.90850+04	1.00000+00
4	8	1	3	78	6.15400+02	1.02000+03	0.00000	1.37000+01	0.00000	0.00000	0.00000
1	8	1	3	79	7.00000-01	1.05259+02	1.90316+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	8	1	3	79	1.67640+00	1.44780+00	8.34000+01	1.31400+02	5.70000+00	0.00000	2.44000+01
3	8	1	3	79	1.31400+02	0.00000	0.00000	-2.00000+00	0.00000	1.96862+04	1.00000+00
4	8	1	3	79	5.13400+02	8.59700+02	0.00000	1.54300+01	0.00000	0.00000	0.00000
1	8	1	3	80	7.00000-01	1.03707+02	1.87351+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	8	1	3	80	1.67640+00	1.44780+00	8.21000+01	1.27500+02	5.20000+00	0.00000	2.49000+01
3	8	1	3	80	1.27500+02	0.00000	0.00000	-4.00000+00	0.00000	1.97724+04	1.00000+00
4	8	1	3	80	5.19400+02	1.00370+03	0.00000	1.45700+01	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	A	1	3	A1	7.00000-01	1.04432+02	1.88739+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	A1	1.67640+00	1.44780+00	8.27000+01	1.29000+02	5.50000+00	0.00000	2.49000+01
3	A	1	3	A1	1.29000+02	0.00000	0.00000	-4.00000+00	0.00000	1.97724+04	1.00000+00
4	A	1	3	A1	5.77700+02	1.10830+03	0.00000	1.62900+01	0.00000	0.00000	0.00000
1	A	1	3	A2	8.00000-01	7.05870+01	1.27572+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	A2	1.67640+00	1.44780+00	5.59000+01	1.41400+02	6.50000+00	0.00000	2.47000+01
3	A	1	3	A2	1.41400+02	0.00000	0.00000	9.00000+00	0.00000	2.05320+04	1.00000+00
4	A	1	3	A2	5.67400+02	1.05430+03	0.00000	6.00000+00	0.00000	0.00000	0.00000
1	A	1	3	A3	7.00000-01	7.07940+01	1.28013+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	A3	1.67640+00	1.44780+00	5.61000+01	1.36200+02	6.00000+00	0.00000	2.51000+01
3	A	1	3	A3	1.36200+02	0.00000	0.00000	1.00000+01	0.00000	1.97607+04	1.00000+00
4	A	1	3	A3	5.59700+02	1.18200+03	0.00000	5.10000+00	0.00000	0.00000	0.00000
1	A	1	3	A4	7.00000-01	7.01730+01	1.26878+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	A4	1.67640+00	1.44780+00	5.56000+01	1.26700+02	4.90000+00	0.00000	2.55000+01
3	A	1	3	A4	1.26700+02	0.00000	0.00000	1.00000+01	0.00000	1.98796+04	1.00000+00
4	A	1	3	A4	5.08300+02	1.16740+03	0.00000	4.30000+00	0.00000	0.00000	0.00000
1	A	1	3	A5	9.00000-01	6.92415+01	1.25048+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	A5	1.67640+00	1.44780+00	5.48000+01	1.17200+02	3.70000+00	0.00000	2.45000+01
3	A	1	3	A5	1.17200+02	0.00000	0.00000	1.00000+01	0.00000	2.04597+04	1.00000+00
4	A	1	3	A5	4.59400+02	1.12970+03	0.00000	4.30000+00	0.00000	0.00000	0.00000
1	A	1	3	A6	7.00000-01	6.92415+01	1.25048+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	A6	1.67640+00	1.44780+00	5.48000+01	1.19700+02	3.70000+00	0.00000	2.54000+01
3	A	1	3	A6	9.47000+01	0.00000	4.00000+00	1.00000+01	0.00000	2.02733+04	2.00000+00
4	A	1	3	A6	2.79400+02	1.07310+03	0.00000	4.30000+00	0.00000	0.00000	0.00000
1	A	1	3	A7	7.00000-01	1.15299+02	2.08361+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	A7	1.67640+00	1.44780+00	9.13000+01	1.18400+02	4.30000+00	0.00000	2.56000+01
3	A	1	3	A7	1.15800+02	0.00000	4.00000+00	-4.00000+00	0.00000	1.93646+04	2.00000+00
4	A	1	3	A7	4.76600+02	8.82000+02	0.00000	0.00000	0.00000	0.00000	0.00000
1	A	1	3	A8	7.00000-01	1.15817+02	2.09276+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	A8	1.67640+00	1.44780+00	9.17000+01	1.26200+02	4.70000+00	0.00000	2.57000+01
3	A	1	3	A8	1.04700+02	0.00000	0.00000	2.00000+00	3.00000+01	1.94369+04	3.00000+00
4	A	1	3	A8	3.94300+02	8.26300+02	0.00000	1.29000+01	0.00000	0.00000	0.00000
1	A	1	3	A9	7.00000-01	1.16024+02	2.09717+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	A9	1.67640+00	1.44780+00	9.19000+01	1.19100+02	3.50000+00	0.00000	2.51000+01
3	A	1	3	A9	9.97000+01	0.00000	0.00000	1.00000+00	1.00000+01	2.01592+04	3.00000+00
4	A	1	3	A9	3.30000+02	8.06600+02	0.00000	6.51000+01	0.00000	0.00000	0.00000
1	A	1	3	90	6.00000-01	1.15506+02	2.08802+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	90	1.67640+00	1.44780+00	9.15000+01	1.15100+02	3.50000+00	0.00000	2.49000+01
3	A	1	3	90	9.90000+01	0.00000	0.00000	1.00000+00	0.00000	2.00427+04	3.00000+00
4	A	1	3	90	2.94900+02	1.06290+03	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	A	1	3	91	6.00000-01	1.16541+02	2.10632+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	91	1.67640+00	1.44780+00	9.23000+01	1.26900+02	4.60000+00	0.00000	2.42000+01
3	A	1	3	91	1.06000+02	0.00000	0.00000	-5.00000+00	0.00000	2.05320+04	3.00000+00
4	A	1	3	91	3.33400+02	8.03100+02	0.00000	1.37000+01	0.00000	0.00000	0.00000
1	A	1	3	92	8.00000-01	1.04845+02	1.89402+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	92	1.67640+00	1.44780+00	8.30000+01	1.36800+02	5.80000+00	0.00000	2.40000+01
3	A	1	3	92	1.28200+02	0.00000	0.00000	2.00000+00	0.00000	2.00427+04	3.00000+00
4	A	1	3	92	5.09100+02	1.08600+03	0.00000	0.00000	0.00000	0.00000	0.00000
1	A	1	3	93	8.00000-01	1.02672+02	1.85521+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	93	1.67640+00	1.44780+00	8.13000+01	1.35800+02	5.80000+00	0.00000	2.39000+01
3	A	1	3	93	1.18800+02	0.00000	0.00000	1.00000+00	0.00000	2.03223+04	3.00000+00
4	A	1	3	93	4.72300+02	1.15030+03	0.00000	0.00000	0.00000	0.00000	0.00000
1	A	1	3	94	8.00000-01	1.02361+02	1.85080+02	1.50485+06	2.00000+01	1.00000+00	0.00000
2	A	1	3	94	1.67640+00	1.44780+00	8.11000+01	1.30000+02	5.00000+00	0.00000	2.40000+01
3	A	1	3	94	1.11500+02	0.00000	0.00000	3.00000+00	0.00000	2.05529+04	3.00000+00
4	A	1	3	94	4.15700+02	1.13910+03	0.00000	0.00000	0.00000	0.00000	0.00000
1	A	1	3	95	6.00000-01	6.92415+01	1.25048+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	95	1.67640+00	1.44780+00	5.48000+01	1.32500+02	5.50000+00	0.00000	2.31000+01
3	A	1	3	95	1.06100+02	0.00000	0.00000	7.00000+00	1.00000+01	2.05529+04	3.00000+00
4	A	1	3	95	2.92300+02	8.22000+02	0.00000	3.40000+00	0.00000	0.00000	0.00000
1	A	1	3	96	7.00000-01	6.82065+01	1.23218+02	1.50485+06	1.60000+01	1.00000+00	0.00000
2	A	1	3	96	1.67640+00	1.44780+00	5.40000+01	1.34200+02	5.40000+00	0.00000	2.41000+01
3	A	1	3	96	1.07000+02	0.00000	0.00000	1.20000+01	1.00000+01	2.03223+04	3.00000+00
4	A	1	3	96	2.86300+02	8.86300+02	0.00000	4.30000+00	0.00000	0.00000	0.00000
1	13	1	3	97	1.59000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	97	1.49870+00	2.43840+00	1.00000+02	1.30000+02	4.92000+00	0.00000	5.51000+00
3	13	1	3	97	1.30000+02	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	1.00000+00
4	13	1	3	97	3.65000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	98	1.59000+00	1.33411+02	7.54894+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	98	1.49870+00	2.43840+00	9.69000+01	1.17000+02	3.14000+00	0.00000	5.51000+00
3	13	1	3	98	1.17000+02	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	1.00000+00
4	13	1	3	98	1.96000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	99	1.59000+00	1.37655+02	7.79184+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	99	1.49870+00	2.43840+00	1.00000+02	1.29400+02	4.78000+00	0.00000	5.51000+00
3	13	1	3	99	1.16500+02	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	3.00000+00
4	13	1	3	99	2.94000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	100	1.59000+00	1.35585+02	7.67512+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	100	1.49870+00	2.43840+00	9.85000+01	1.27500+02	4.69000+00	0.00000	5.51000+00
3	13	1	3	100	1.02000+02	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	3.00000+00
4	13	1	3	100	2.65000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	13	1	3	101	1.59000+00	1.36517+02	7.72875+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	101	1.49870+00	2.43840+00	9.92000+01	1.18100+02	3.54000+00	0.00000	5.51000+00
3	13	1	3	101	1.06200+02	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	3.00000+00
4	13	1	3	101	1.82000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	102	1.59000+00	1.36517+02	7.72875+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	102	1.49870+00	2.43840+00	9.92000+01	1.20000+02	3.82000+00	0.00000	5.51000+00
3	13	1	3	102	9.60000+01	0.00000	0.00000	-1.70000+01	0.00000	3.01735+04	3.00000+00
4	13	1	3	102	1.89000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	103	1.56000+00	1.00602+02	5.69719+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	103	1.49870+00	2.43840+00	7.31000+01	1.51000+02	7.29000+00	0.00000	6.96000+00
3	13	1	3	103	1.51000+02	0.00000	0.00000	-2.00000+00	0.00000	2.95561+04	1.00000+00
4	13	1	3	103	4.52000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	104	1.56000+00	9.84285+01	5.57101+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	104	1.49870+00	2.43840+00	7.15000+01	1.50800+02	7.12000+00	0.00000	6.96000+00
3	13	1	3	104	1.35700+02	0.00000	0.00000	-2.00000+00	0.00000	2.95561+04	3.00000+00
4	13	1	3	104	4.11000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	105	1.56000+00	9.84285+01	5.57101+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	105	1.49870+00	2.43840+00	7.15000+01	1.29400+02	4.82000+00	0.00000	6.96000+00
3	13	1	3	105	1.16500+02	0.00000	0.00000	-2.00000+00	0.00000	2.95561+04	3.00000+00
4	13	1	3	105	2.53000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	106	1.56000+00	9.95670+01	5.63410+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	13	1	3	106	1.49870+00	2.43840+00	7.23000+01	1.49300+02	7.11000+00	0.00000	6.96000+00
3	13	1	3	106	1.12000+02	0.00000	4.00000+00	-2.00000+00	0.00000	2.95561+04	2.00000+00
4	13	1	3	106	3.30000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	107	1.56000+00	1.00602+02	5.69719+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	13	1	3	107	1.49870+00	2.43840+00	7.31000+01	1.28000+02	4.59000+00	0.00000	6.96000+00
3	13	1	3	107	9.60000+01	0.00000	4.00000+00	-2.00000+00	0.00000	2.95561+04	2.00000+00
4	13	1	3	107	2.12000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	108	1.56000+00	9.84285+01	5.57101+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	13	1	3	108	1.49870+00	2.43840+00	7.15000+01	1.47000+02	6.81000+00	0.00000	6.96000+00
3	13	1	3	108	9.90000+01	0.00000	4.00000+00	-2.00000+00	0.00000	2.95561+04	4.00000+00
4	13	1	3	108	2.72000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	109	1.56000+00	1.00602+02	5.69719+01	3.23472+05	1.20000+01	1.00000+00	0.00000
2	13	1	3	109	1.49870+00	2.43840+00	7.31000+01	1.24500+02	4.31000+00	0.00000	6.96000+00
3	13	1	3	109	8.41000+01	0.00000	4.00000+00	-2.00000+00	0.00000	2.95561+04	4.00000+00
4	13	1	3	109	1.92000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	110	1.55000+00	5.71320+01	3.23346+01	3.23472+05	8.00000+00	1.00000+00	0.00000
2	13	1	3	110	1.49870+00	2.43840+00	4.15000+01	1.70000+02	8.77000+00	0.00000	1.23000+01
3	13	1	3	110	1.70000+02	0.00000	0.00000	9.00000+00	0.00000	2.87242+04	1.00000+00
4	13	1	3	110	2.84000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1	13	1	3	111	1.55000+00	5.71320+01	3.23346+01	3.23472+05	8.00000+00	1.00000+00	0.00000
2	13	1	3	111	1.49870+00	2.43840+00	4.15000+01	1.48000+02	6.93000+00	0.00000	1.23000+01
3	13	1	3	111	1.48000+02	0.00000	0.00000	9.00000+00	0.00000	2.87242+04	1.00000+00
4	13	1	3	111	2.54000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	112	1.45000+00	1.40863+02	7.97165+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	112	1.49870+00	2.43840+00	1.02300+02	1.27000+02	4.26000+00	0.00000	1.01500+01
3	13	1	3	112	1.27000+02	0.00000	0.00000	1.00000+00	0.00000	2.95327+04	1.00000+00
4	13	1	3	112	3.14000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	13	1	3	113	1.45000+00	1.33411+02	7.54894+01	3.23472+05	1.60000+01	1.00000+00	0.00000
2	13	1	3	113	1.49870+00	2.43840+00	9.69000+01	1.28000+02	4.68000+00	0.00000	1.01500+01
3	13	1	3	113	1.15200+02	0.00000	0.00000	0.00000	0.00000	2.95327+04	3.00000+00
4	13	1	3	113	2.43000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	1	3	114	1.36000+00	1.29064+02	3.89971+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	114	1.52400+00	0.00000	8.37000+01	1.17000+02	5.00000+00	0.00000	9.34000+00
3	10	1	3	114	1.17000+02	0.00000	0.00000	-8.00000+00	0.00000	3.24336+04	1.00000+00
4	10	1	3	114	3.96000+02	0.00000	0.00000	3.60000+01	0.00000	0.00000	0.00000
1	10	1	3	115	1.32000+00	1.24717+02	3.76910+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	115	1.52400+00	0.00000	8.09000+01	1.15000+02	4.50000+00	0.00000	8.82000+00
3	10	1	3	115	1.15000+02	0.00000	0.00000	-8.00000+00	0.00000	3.24219+04	1.00000+00
4	10	1	3	115	3.70000+02	0.00000	0.00000	4.70000+01	0.00000	0.00000	0.00000
1	10	1	3	116	1.52000+00	1.29996+02	3.92747+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	116	1.52400+00	0.00000	8.43000+01	1.41500+02	6.30000+00	0.00000	1.05800+01
3	10	1	3	116	1.00000+02	0.00000	4.00000+00	0.00000	0.00000	3.13641+04	2.00000+00
4	10	1	3	116	3.34000+02	0.00000	0.00000	3.30000+01	0.00000	0.00000	0.00000
1	10	1	3	117	1.42000+00	1.28650+02	3.88551+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	117	1.52400+00	0.00000	8.34000+01	1.30100+02	4.90000+00	0.00000	7.95000+00
3	10	1	3	117	9.40000+01	0.00000	4.00000+00	0.00000	0.00000	3.18558+04	2.00000+00
4	10	1	3	117	2.88000+02	0.00000	0.00000	5.00000+01	0.00000	0.00000	0.00000
1	10	1	3	118	1.38000+00	1.24717+02	3.76910+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	118	1.52400+00	0.00000	8.09000+01	1.28100+02	4.60000+00	0.00000	8.46000+00
3	10	1	3	118	9.20000+01	0.00000	4.00000+00	-8.00000+00	0.00000	3.03319+04	2.00000+00
4	10	1	3	118	3.47000+02	0.00000	0.00000	4.80000+01	0.00000	0.00000	0.00000
1	10	1	3	119	1.41000+00	1.23372+02	3.72715+02	9.73639+05	1.60000+01	1.00000+00	0.00000
2	10	1	3	119	1.52400+00	0.00000	8.00000+01	1.17700+02	3.30000+00	0.00000	9.15000+00
3	10	1	3	119	8.70000+01	0.00000	4.00000+00	-8.00000+00	0.00000	3.17206+04	2.00000+00
4	10	1	3	119	2.58000+02	0.00000	0.00000	1.77000+02	0.00000	0.00000	0.00000
1	10	1	3	120	1.51000+00	1.43244+02	4.32810+02	9.73639+05	2.00000+01	1.00000+00	0.00000
2	10	1	3	120	1.52400+00	0.00000	9.29000+01	1.15000+02	4.70000+00	0.00000	8.15000+00
3	10	1	3	120	1.15000+02	0.00000	0.00000	0.00000	0.00000	2.96959+04	1.00000+00
4	10	1	3	120	4.20000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1 10 1 3 121	1.50000+00	1.44486+02	4.36532+02	9.73639+05	2.00000+01	1.00000+00	0.00000
2 10 1 3 121	1.52400+00	0.00000	9.37000+01	1.07000+02	2.80000+00	0.00000	9.03000+00
3 10 1 3 121	1.07000+02	0.00000	0.00000	0.00000	0.00000	2.96050+04	1.00000+00
4 10 1 3 121	3.36000+02	0.00000	0.00000	2.27000+02	0.00000	0.00000	0.00000
1 10 1 3 122	1.46000+00	1.53283+02	4.63094+02	9.73639+05	2.00000+01	1.00000+00	0.00000
2 10 1 3 122	1.52400+00	0.00000	9.94000+01	1.15000+02	4.40000+00	0.00000	6.32000+00
3 10 1 3 122	1.15000+02	0.00000	0.00000	0.00000	0.00000	3.09610+04	1.00000+00
4 10 1 3 122	4.15000+02	0.00000	0.00000	2.40000+01	0.00000	0.00000	0.00000
1 10 1 3 123	1.46000+00	1.53283+02	4.63094+02	9.73639+05	2.00000+01	1.00000+00	0.00000
2 10 1 3 123	1.52400+00	0.00000	9.94000+01	1.12000+02	3.90000+00	0.00000	6.73000+00
3 10 1 3 123	1.12000+02	0.00000	0.00000	0.00000	0.00000	3.10496+04	1.00000+00
4 10 1 3 123	3.98000+02	0.00000	0.00000	1.15000+02	0.00000	0.00000	0.00000
1 10 1 3 124	1.42000+00	8.18685+01	2.47383+02	9.73639+05	1.20000+01	1.00000+00	0.00000
2 10 1 3 124	1.52400+00	0.00000	5.31000+01	1.55400+02	7.70000+00	0.00000	3.44000+00
3 10 1 3 124	1.00000+02	0.00000	4.00000+00	0.00000	0.00000	3.09541+04	2.00000+00
4 10 1 3 124	3.38000+02	0.00000	0.00000	2.20000+01	0.00000	0.00000	0.00000
1 10 1 3 125	1.42000+00	8.11440+01	2.45049+02	9.73639+05	1.20000+01	1.00000+00	0.00000
2 10 1 3 125	1.52400+00	0.00000	5.26000+01	1.48500+02	7.10000+00	0.00000	3.44000+00
3 10 1 3 125	9.70000+01	0.00000	4.00000+00	0.00000	0.00000	3.09541+04	2.00000+00
4 10 1 3 125	2.61000+02	0.00000	0.00000	3.00000+01	0.00000	0.00000	0.00000
1 10 1 3 126	1.42000+00	8.18685+01	2.47383+02	9.73639+05	1.20000+01	1.00000+00	0.00000
2 10 1 3 126	1.52400+00	0.00000	5.31000+01	1.20400+02	3.70000+00	0.00000	3.44000+00
3 10 1 3 126	8.30000+01	0.00000	4.00000+00	0.00000	0.00000	3.09541+04	2.00000+00
4 10 1 3 126	1.89000+02	0.00000	0.00000	2.81000+02	0.00000	0.00000	0.00000
1 10 1 3 127	1.42000+00	7.92810+01	2.39465+02	9.73639+05	1.20000+01	1.00000+00	0.00000
2 10 1 3 127	1.52400+00	0.00000	5.14000+01	1.22000+02	3.90000+00	0.00000	3.44000+00
3 10 1 3 127	8.40000+01	0.00000	4.00000+00	0.00000	0.00000	3.09541+04	2.00000+00
4 10 1 3 127	2.00000+02	0.00000	0.00000	2.11000+02	0.00000	0.00000	0.00000
1 11 1 3 128	1.57000+00	1.38587+02	4.52242+02	8.95115+05	2.00000+01	1.00000+00	0.00000
2 11 1 3 128	0.00000	0.00000	1.03000+02	1.25000+02	4.40000+00	0.00000	1.39900+01
3 11 1 3 128	1.25000+02	0.00000	0.00000	0.00000	0.00000	2.70676+04	1.00000+00
4 11 1 3 128	5.68000+02	0.00000	0.00000	2.40000+01	0.00000	1.48000+00	0.00000
1 11 1 3 129	1.47000+00	1.33722+02	4.36406+02	8.95115+05	2.00000+01	1.00000+00	0.00000
2 11 1 3 129	0.00000	0.00000	9.94000+01	1.21000+02	3.90000+00	0.00000	1.22300+01
3 11 1 3 129	1.21000+02	0.00000	0.00000	0.00000	0.00000	2.80485+04	1.00000+00
4 11 1 3 129	4.94000+02	0.00000	0.00000	3.00000+01	0.00000	0.00000	0.00000
1 11 1 3 130	1.57000+00	1.33722+02	4.36406+02	8.95115+05	2.00000+01	1.00000+00	0.00000
2 11 1 3 130	0.00000	0.00000	9.94000+01	1.09000+02	2.10000+00	0.00000	1.09700+01
3 11 1 3 130	1.09000+02	0.00000	0.00000	0.00000	0.00000	2.79717+04	1.00000+00
4 11 1 3 130	1.79000+02	0.00000	0.00000	2.25000+02	0.00000	0.00000	0.00000

TABLE C-1. (Continued)

TANGENTIAL COAL FIRED BOILERS

1 11 1 3 131	1.58000+00	1.25545+02	4.09624+02	8.95115+05	1.60000+01	1.00000+00	0.00000
2 11 1 3 131	0.00000	0.00000	9.33000+01	1.14100+02	2.70000+00	0.00000	1.33800+01
3 11 1 3 131	8.80000+01	0.00000	4.00000+00	0.00000	0.00000	2.77759+04	2.00000+00
4 11 1 3 131	2.36000+02	0.00000	0.00000	4.40000+01	0.00000	0.00000	0.00000
1 11 1 3 132	1.58000+00	1.04432+02	3.40696+02	8.95115+05	2.00000+01	1.00000+00	0.00000
2 11 1 3 132	0.00000	0.00000	7.76000+01	1.27000+02	4.90000+00	0.00000	1.29300+01
3 11 1 3 132	1.27000+02	0.00000	0.00000	0.00000	0.00000	2.75220+04	1.00000+00
4 11 1 3 132	5.37000+02	0.00000	0.00000	3.00000+01	0.00000	0.00000	0.00000
1 11 1 3 133	1.58000+00	1.05984+02	3.45964+02	8.95115+05	1.60000+01	1.00000+00	0.00000
2 11 1 3 133	0.00000	0.00000	7.88000+01	1.29400+02	4.90000+00	0.00000	1.29300+01
3 11 1 3 133	9.90000+01	0.00000	4.00000+00	0.00000	0.00000	2.75220+04	2.00000+00
4 11 1 3 133	3.04000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1 11 1 3 134	1.58000+00	1.08054+02	3.52557+02	8.95115+05	1.60000+01	1.00000+00	0.00000
2 11 1 3 134	0.00000	0.00000	8.03000+01	1.19900+02	3.60000+00	0.00000	1.29300+01
3 11 1 3 134	9.10000+01	0.00000	4.00000+00	0.00000	0.00000	2.75220+04	2.00000+00
4 11 1 3 134	2.65000+02	0.00000	0.00000	6.20000+01	0.00000	0.00000	0.00000
1 11 1 3 135	1.58000+00	8.11440+01	2.64765+02	8.95115+05	1.60000+01	1.00000+00	0.00000
2 11 1 3 135	0.00000	0.00000	6.03000+01	1.18000+02	4.20000+00	0.00000	1.29300+01
3 11 1 3 135	1.18000+02	0.00000	0.00000	0.00000	0.00000	2.75220+04	2.00000+00
4 11 1 3 135	4.58000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1 11 1 3 136	1.58000+00	8.07300+01	2.63440+02	8.95115+05	1.20000+01	1.00000+00	0.00000
2 11 1 3 136	0.00000	0.00000	6.00000+01	1.26200+02	4.50000+00	0.00000	1.29300+01
3 11 1 3 136	7.80000+01	0.00000	4.00000+00	0.00000	0.00000	2.75220+04	2.00000+00
4 11 1 3 136	1.69000+02	0.00000	0.00000	2.70000+01	0.00000	0.00000	0.00000
1 11 1 3 137	1.58000+00	8.15580+01	2.66058+02	8.95115+05	1.20000+01	1.00000+00	0.00000
2 11 1 3 137	0.00000	0.00000	6.06000+01	1.17100+02	3.20000+00	0.00000	1.29300+01
3 11 1 3 137	7.40000+01	0.00000	4.00000+00	0.00000	0.00000	2.75220+04	2.00000+00
4 11 1 3 137	1.82000+02	0.00000	0.00000	5.60000+01	0.00000	0.00000	0.00000
1 12 1 3 138	7.50000-01	1.15092+02	2.69718+02	1.01319+06	2.00000+01	1.00000+00	0.00000
2 12 1 3 138	0.00000	0.00000	9.00000+01	1.24000+02	4.20000+00	0.00000	1.59200+01
3 12 1 3 138	1.24000+02	0.00000	0.00000	0.00000	0.00000	2.32161+04	1.00000+00
4 12 1 3 138	4.34000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1 12 1 3 139	7.50000-01	1.13850+02	2.67036+02	1.01319+06	2.00000+01	1.00000+00	0.00000
2 12 1 3 139	0.00000	0.00000	8.91000+01	1.17000+02	3.20000+00	0.00000	1.65100+01
3 12 1 3 139	1.17000+02	0.00000	0.00000	0.00000	0.00000	2.36215+04	1.00000+00
4 12 1 3 139	3.86000+02	0.00000	0.00000	5.60000+01	0.00000	0.00000	0.00000
1 14 1 3 140	1.43000+00	1.59390+02	2.09654+02	6.54269+05	4.80000+01	2.00000+00	0.00000
2 14 1 3 140	0.00000	0.00000	1.00000+02	1.17000+02	3.10000+00	0.00000	1.00500+01
3 14 1 3 140	1.17000+02	0.00000	0.00000	0.00000	0.00000	3.08818+04	1.00000+00
4 14 1 3 140	4.10000+02	0.00000	0.00000	6.10000+01	0.00000	0.00000	0.00000

TABLE C-1. (Concluded)

TANGENTIAL COAL FIRED BOILERS

1	14	1	3	141	1.43000+00	1.59390+02	2.09654+02	6.54269+05	4.80000+01	2.00000+00	0.00000
2	14	1	3	141	0.00000	0.00000	1.00000+02	1.06000+02	1.30000+00	0.00000	1.00500+01
3	14	1	3	141	1.06000+02	0.00000	0.00000	0.00000	0.00000	3.08818+04	1.00000+00
4	14	1	3	141	3.10000+02	0.00000	0.00000	1.00000+02	0.00000	0.00000	0.00000
1	15	1	3	142	1.40000+00	1.01223+02	2.44260+02	1.40845+06	4.00000+01	2.00000+00	0.00000
2	15	1	3	142	0.00000	0.00000	8.73000+01	1.17000+02	3.10000+00	0.00000	8.09000+00
3	15	1	3	142	1.17000+02	0.00000	0.00000	0.00000	0.00000	3.08725+04	1.00000+00
4	15	1	3	142	3.87000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	143	1.40000+00	1.01223+02	2.44260+02	1.40845+06	4.00000+01	2.00000+00	0.00000
2	15	1	3	143	0.00000	0.00000	8.73000+01	1.11000+02	2.20000+00	0.00000	8.09000+00
3	15	1	3	143	1.11000+02	0.00000	0.00000	0.00000	0.00000	3.08725+04	1.00000+00
4	15	1	3	143	3.85000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	144	1.40000+00	9.73935+01	2.35017+02	1.40845+06	4.00000+01	2.00000+00	0.00000
2	15	1	3	144	0.00000	0.00000	8.40000+01	1.11300+02	2.30000+00	0.00000	8.09000+00
3	15	1	3	144	8.90000+01	0.00000	8.00000+00	0.00000	0.00000	3.08725+04	2.00000+00
4	15	1	3	144	2.54000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	145	1.40000+00	9.27360+01	2.23818+02	1.40845+06	4.00000+01	2.00000+00	0.00000
2	15	1	3	145	0.00000	0.00000	8.00000+01	1.09000+02	1.90000+00	0.00000	8.09000+00
3	15	1	3	145	1.09000+02	0.00000	0.00000	0.00000	0.00000	3.08725+04	1.00000+00
4	15	1	3	145	3.45000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	146	1.40000+00	9.27360+01	2.23818+02	1.40845+06	4.80000+01	2.00000+00	0.00000
2	15	1	3	146	0.00000	0.00000	8.00000+01	1.12000+02	2.40000+00	0.00000	8.09000+00
3	15	1	3	146	8.90000+01	0.00000	8.00000+00	0.00000	0.00000	3.08725+04	2.00000+00
4	15	1	3	146	1.77000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	147	1.40000+00	6.74820+01	1.62840+02	1.40845+06	2.40000+01	2.00000+00	0.00000
2	15	1	3	147	0.00000	0.00000	5.82000+01	1.07000+02	1.50000+00	0.00000	8.09000+00
3	15	1	3	147	1.07000+02	0.00000	0.00000	1.00000+01	0.00000	3.08725+04	1.00000+00
4	15	1	3	147	2.74000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	148	1.40000+00	6.74820+01	1.62840+02	1.40845+06	2.40000+01	2.00000+00	0.00000
2	15	1	3	148	0.00000	0.00000	5.82000+01	1.13000+02	2.50000+00	0.00000	8.09000+00
3	15	1	3	148	8.50000+01	0.00000	8.00000+00	1.00000+01	0.00000	3.08725+04	2.00000+00
4	15	1	3	148	1.52000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	15	1	3	149	1.40000+00	6.31764+01	1.52493+02	1.40845+06	2.40000+01	2.00000+00	0.00000
2	15	1	3	149	0.00000	0.00000	5.45000+01	1.08000+02	1.70000+00	0.00000	8.09000+00
3	15	1	3	149	8.10000+01	0.00000	8.00000+00	0.00000	0.00000	3.08725+04	2.00000+00
4	15	1	3	149	1.95000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-2. NO_x CONTROL TEST DATA OPPOSED WALL COAL-FIRED BOILERS

1	1	2	3	1	1.17000+00	1.08054+02	1.87730+02	2.07297+06	2.40000+01	2.00000+00	0.00000
2	1	2	3	1	0.00000	0.00000	7.04000+01	1.49000+02	7.10000+00	0.00000	5.45000+00
3	1	2	3	1	1.49000+02	0.00000	0.00000	0.00000	0.00000	3.00407+04	1.00000+00
4	1	2	3	1	7.67000+02	0.00000	0.00000	1.12000+01	0.00000	0.00000	0.00000
1	1	2	3	2	1.17000+00	1.08571+02	1.88518+02	2.07297+06	2.40000+01	2.00000+00	0.00000
2	1	2	3	2	0.00000	0.00000	7.07000+01	1.47800+02	7.00000+00	0.00000	5.45000+00
3	1	2	3	2	1.18000+02	0.00000	6.00000+00	0.00000	0.00000	3.00407+04	2.00000+00
4	1	2	3	2	7.33000+02	0.00000	0.00000	1.10000+01	0.00000	0.00000	0.00000
1	1	2	3	3	1.17000+00	1.08571+02	1.88518+02	2.07297+06	1.80000+01	2.00000+00	0.00000
2	1	2	3	3	0.00000	0.00000	7.07000+01	1.46500+02	6.90000+00	0.00000	5.45000+00
3	1	2	3	3	8.82000+01	0.00000	1.20000+01	0.00000	0.00000	3.00407+04	2.00000+00
4	1	2	3	3	7.23000+02	0.00000	0.00000	1.08000+01	0.00000	0.00000	0.00000
1	1	2	3	4	1.17000+00	1.46867+02	2.55175+02	2.07297+06	3.00000+01	2.00000+00	0.00000
2	1	2	3	4	0.00000	0.00000	9.57000+01	1.39000+02	6.10000+00	0.00000	5.45000+00
3	1	2	3	4	1.39000+02	0.00000	0.00000	0.00000	0.00000	3.00407+04	1.00000+00
4	1	2	3	4	9.08000+02	0.00000	0.00000	1.22000+01	0.00000	0.00000	0.00000
1	1	2	3	5	1.17000+00	1.44279+02	2.50664+02	2.07297+06	3.00000+01	2.00000+00	0.00000
2	1	2	3	5	0.00000	0.00000	9.40000+01	1.38000+02	5.90000+00	0.00000	5.45000+00
3	1	2	3	5	1.38000+02	0.00000	0.00000	0.00000	0.00000	3.00407+04	1.00000+00
4	1	2	3	5	9.02000+02	0.00000	0.00000	1.25000+01	0.00000	0.00000	0.00000
1	2	2	3	6	1.38000+00	1.42726+02	2.13976+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	3	6	0.00000	0.00000	9.38000+01	1.40000+02	6.20000+00	0.00000	1.14000+00
3	2	2	3	6	1.40000+02	0.00000	0.00000	0.00000	0.00000	2.99778+04	1.00000+00
4	2	2	3	6	8.38000+02	0.00000	0.00000	3.00000+00	0.00000	0.00000	0.00000
1	2	2	3	7	1.38000+00	1.17162+02	1.75648+02	1.52770+06	2.00000+01	1.00000+00	1.00000+00
2	2	2	3	7	0.00000	0.00000	7.70000+01	1.29000+02	4.90000+00	0.00000	1.14000+00
3	2	2	3	7	1.29000+02	0.00000	0.00000	0.00000	0.00000	2.99778+04	1.00000+00
4	2	2	3	7	7.81000+02	0.00000	0.00000	1.80000+01	0.00000	0.00000	0.00000
1	2	2	3	8	1.38000+00	9.09765+01	1.36436+02	1.52770+06	2.00000+01	1.00000+00	1.00000+00
2	2	2	3	8	0.00000	0.00000	5.98000+01	1.35000+02	5.80000+00	0.00000	1.41000+00
3	2	2	3	8	1.35000+02	0.00000	0.00000	0.00000	0.00000	3.04275+04	1.00000+00
4	2	2	3	8	6.65000+02	0.00000	0.00000	2.30000+01	0.00000	0.00000	0.00000
1	2	2	3	9	1.38000+00	9.28395+01	1.39149+02	1.52770+06	2.00000+01	1.00000+00	1.00000+00
2	2	2	3	9	0.00000	0.00000	6.10000+01	1.27000+02	4.70000+00	0.00000	1.41000+00
3	2	2	3	9	1.27000+02	0.00000	0.00000	0.00000	0.00000	3.04275+04	1.00000+00
4	2	2	3	9	6.21000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	3	2	3	10	1.19000+00	1.30306+02	2.35396+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	10	1.44780+00	0.00000	8.39000+01	1.29000+02	4.85000+00	0.00000	1.61000+00
3	3	2	3	10	1.29000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	10	7.64000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-2. (Continued)

HORIZONTALLY OPPOSED COAL FIRED BOILERS

1	3	2	3	11	1.19000+00	1.30306+02	2.35396+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	11	1.44780+00	0.00000	8.39000+01	1.24000+02	4.16000+00	0.00000	1.61000+00
3	3	2	3	11	1.24000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	11	7.35000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	12	1.19000+00	1.31238+02	2.37067+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	12	1.44780+00	0.00000	8.45000+01	1.26000+02	4.39000+00	0.00000	1.61000+00
3	3	2	3	12	1.26000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	12	7.30000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	13	1.19000+00	1.27512+02	2.30348+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	13	1.44780+00	0.00000	8.21000+01	1.28000+02	4.73000+00	0.00000	1.61000+00
3	3	2	3	13	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	13	7.85000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	14	1.19000+00	1.26684+02	2.28929+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	14	1.44780+00	0.00000	8.16000+01	1.28000+02	4.70000+00	0.00000	1.61000+00
3	3	2	3	14	1.28000+02	9.70000+00	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	14	6.66000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	15	1.19000+00	1.27201+02	2.29780+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	15	1.44780+00	0.00000	8.19000+01	1.29000+02	4.90000+00	0.00000	1.61000+00
3	3	2	3	15	1.29000+02	1.17000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	15	6.78000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	16	1.19000+00	1.26684+02	2.28929+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	16	1.44780+00	0.00000	8.16000+01	1.30000+02	5.00000+00	0.00000	1.61000+00
3	3	2	3	16	1.30000+02	1.50000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	16	6.56000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	17	1.19000+00	9.84285+01	1.77887+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	17	1.44780+00	0.00000	6.34000+01	1.20000+02	4.70000+00	0.00000	1.61000+00
3	3	2	3	17	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	17	7.23000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	18	1.19000+00	9.70830+01	1.75364+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	18	1.44780+00	0.00000	6.25000+01	1.29000+02	4.85000+00	0.00000	1.61000+00
3	3	2	3	18	1.29000+02	1.57000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	18	5.94000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	19	1.19000+00	1.38690+02	2.50538+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	19	1.44780+00	0.00000	8.93000+01	1.28000+02	4.68000+00	0.00000	1.61000+00
3	3	2	3	19	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	19	7.81000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	20	1.19000+00	1.37551+02	2.48582+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	20	1.44780+00	0.00000	8.86000+01	1.22000+02	3.90000+00	0.00000	1.61000+00
3	3	2	3	20	1.22000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	20	7.77000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED COAL FIRED BOILERS

1	3	2	3	21	1.19000+00	1.39414+02	2.51957+02	1.47232+06	3.80000+01	1.00000+00	0.00000
2	3	2	3	21	1.44780+00	0.00000	8.98000+01	1.27000+02	4.55000+00	0.00000	1.61000+00
3	3	2	3	21	1.20700+02	0.00000	2.00000+00	0.00000	0.00000	2.91716+04	2.00000+00
4	3	2	3	21	7.17000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	22	1.19000+00	1.38690+02	2.50538+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	22	1.44780+00	0.00000	8.93000+01	1.26000+02	4.43000+00	0.00000	1.61000+00
3	3	2	3	22	1.26000+02	1.61000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	22	7.11000+02	0.00000	0.00000	0.00000	4.60100+03	0.00000	0.00000
1	3	2	3	23	1.19000+00	1.45831+02	2.63440+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	23	1.44780+00	0.00000	9.39000+01	1.28000+02	4.69000+00	0.00000	1.61000+00
3	3	2	3	23	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	23	8.93000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	24	1.19000+00	1.45521+02	2.62872+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	24	1.44780+00	0.00000	9.37000+01	1.25000+02	4.31000+00	0.00000	1.61000+00
3	3	2	3	24	1.25000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	24	8.27000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	25	1.19000+00	1.46452+02	2.64576+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	25	1.44780+00	0.00000	9.43000+01	1.25000+02	4.31000+00	0.00000	1.61000+00
3	3	2	3	25	1.25000+02	6.90000+00	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	25	7.80000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	26	1.19000+00	1.44693+02	2.61484+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	26	1.44780+00	0.00000	9.32000+01	1.24500+02	4.23000+00	0.00000	1.61000+00
3	3	2	3	26	1.24500+02	1.50000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	26	7.27000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	27	1.19000+00	1.17058+02	2.11547+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	27	1.44780+00	0.00000	7.54000+01	1.27000+02	4.50000+00	0.00000	1.61000+00
3	3	2	3	27	1.27000+02	0.00000	0.00000	0.00000	0.00000	2.91716+04	1.00000+00
4	3	2	3	27	8.06000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	28	1.19000+00	1.17886+02	2.12935+02	1.47232+06	3.20000+01	1.00000+00	0.00000
2	3	2	3	28	1.44780+00	0.00000	7.59000+01	1.28800+02	4.79000+00	0.00000	1.61000+00
3	3	2	3	28	1.03000+02	0.00000	8.00000+00	0.00000	0.00000	2.91716+04	2.00000+00
4	3	2	3	28	5.49000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	29	1.19000+00	1.30617+02	2.35963+02	1.47232+06	4.00000+01	1.00000+00	0.00000
2	3	2	3	29	1.44780+00	0.00000	8.41000+01	1.27000+02	4.51000+00	0.00000	1.61000+00
3	3	2	3	29	1.27000+02	1.70000+01	0.00000	0.00000	0.00000	2.91716+04	5.00000+00
4	3	2	3	29	6.27000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	2	3	30	1.19000+00	1.30306+02	2.35396+02	1.47232+06	3.20000+01	1.00000+00	0.00000
2	3	2	3	30	1.44780+00	0.00000	8.39000+01	1.23500+02	4.13000+00	0.00000	1.61000+00
3	3	2	3	30	9.88000+01	1.80000+01	8.00000+00	0.00000	0.00000	2.91716+04	6.00000+00
4	3	2	3	30	4.56000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-2. (Continued)

HORIZONTALLY OPPOSED COAL FIRED BOILERS

1	3	2	3	31	1.19000+00	1.26063+02	2.27825+02	1.47232+06	3.20000+01	1.00000+00	0.00000
2	3	2	3	31	1.44780+00	0.00000	8.12000+01	1.30000+02	4.95000+00	0.00000	1.61000+00
3	3	2	3	31	1.04000+02	0.00000	8.00000+00	0.00000	0.00000	2.91716+04	2.00000+00
4	3	2	3	31	4.75000+02	0.00000	0.00000	0.00000	4.60100+03	0.00000	0.00000
1	3	2	3	32	1.19000+00	1.24821+02	2.25585+02	1.47232+06	3.00000+01	1.00000+00	0.00000
2	3	2	3	32	1.44780+00	0.00000	8.04000+01	1.31500+02	5.14000+00	0.00000	1.61000+00
3	3	2	3	32	9.86000+01	2.00000+01	1.00000+01	0.00000	0.00000	2.91716+04	6.00000+00
4	3	2	3	32	4.50000+02	0.00000	0.00000	0.00000	3.18200+03	0.00000	0.00000
1	4	2	3	34	1.84000+00	1.73776+02	3.17667+02	1.30590+06	4.00000+01	1.00000+00	0.00000
2	4	2	3	34	0.00000	0.00000	1.01700+02	1.20000+02	3.70000+00	0.00000	5.62000+00
3	4	2	3	34	1.20000+02	0.00000	0.00000	0.00000	0.00000	3.11451+04	1.00000+00
4	4	2	3	34	7.11000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	4	2	3	35	1.71000+00	1.70878+02	3.12462+02	1.30590+06	4.00000+01	1.00000+00	0.00000
2	4	2	3	35	0.00000	0.00000	1.00000+02	1.07000+02	1.40000+00	0.00000	7.90000+00
3	4	2	3	35	1.07000+02	0.00000	0.00000	0.00000	0.00000	2.99964+04	1.00000+00
4	4	2	3	35	5.49000+02	0.00000	0.00000	8.10000+01	0.00000	0.00000	0.00000
1	4	2	3	36	1.71000+00	1.70878+02	3.12462+02	1.30590+06	3.60000+01	1.00000+00	0.00000
2	4	2	3	36	0.00000	0.00000	1.00000+02	1.16700+02	3.10000+00	0.00000	7.90000+00
3	4	2	3	36	1.05000+02	0.00000	4.00000+00	0.00000	0.00000	2.99964+04	2.00000+00
4	4	2	3	36	6.13000+02	0.00000	0.00000	2.60000+01	0.00000	0.00000	0.00000
1	4	2	3	37	1.74000+00	1.69222+02	3.09371+02	1.30590+06	3.40000+01	1.00000+00	0.00000
2	4	2	3	37	0.00000	0.00000	9.90000+01	1.09600+02	1.90000+00	0.00000	1.39200+01
3	4	2	3	37	9.30000+01	0.00000	6.00000+00	0.00000	0.00000	3.02574+04	2.00000+00
4	4	2	3	37	5.82000+02	0.00000	0.00000	1.22000+02	0.00000	0.00000	0.00000
1	4	2	3	38	1.81000+00	1.69844+02	3.10601+02	1.30590+06	3.40000+01	1.00000+00	0.00000
2	4	2	3	38	0.00000	0.00000	9.94000+01	1.05900+02	1.20000+00	0.00000	6.92000+00
3	4	2	3	38	9.00000+01	0.00000	6.00000+00	0.00000	0.00000	3.05416+04	2.00000+00
4	4	2	3	38	4.63000+02	0.00000	0.00000	1.27000+02	0.00000	0.00000	0.00000
1	4	2	3	39	1.82000+00	1.70878+02	3.12462+02	1.30590+06	3.40000+01	1.00000+00	0.00000
2	4	2	3	39	0.00000	0.00000	1.00400+02	1.07000+02	1.40000+00	0.00000	5.07000+00
3	4	2	3	39	9.10000+01	0.00000	6.00000+00	0.00000	0.00000	3.16321+04	2.00000+00
4	4	2	3	39	5.17000+02	0.00000	0.00000	1.58000+02	0.00000	0.00000	0.00000
1	4	2	3	40	1.71000+00	1.42002+02	2.59686+02	1.30590+06	4.00000+01	1.00000+00	0.00000
2	4	2	3	40	0.00000	0.00000	8.31000+01	1.16000+02	3.00000+00	0.00000	5.10000+00
3	4	2	3	40	1.16000+02	0.00000	0.00000	0.00000	0.00000	3.02248+04	1.00000+00
4	4	2	3	40	5.37000+02	0.00000	0.00000	2.80000+01	0.00000	0.00000	0.00000
1	4	2	3	41	1.73000+00	1.42416+02	2.60411+02	1.30590+06	3.00000+01	1.00000+00	0.00000
2	4	2	3	41	0.00000	0.00000	8.33300+01	1.07300+02	1.50000+00	0.00000	5.71000+00
3	4	2	3	41	8.00000+01	0.00000	1.00000+01	0.00000	0.00000	3.04275+04	2.00000+00
4	4	2	3	41	3.34000+02	0.00000	0.00000	9.24000+02	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED COAL FIRED BOILERS

1	5	2	3	42	1.04000+00	1.34550+02	2.08550+02	6.78002+05	2.00000+01	1.00000+00	0.00000
2	5	2	3	42	0.00000	0.00000	1.00000+02	1.22000+02	3.90000+00	0.00000	3.64400+01
3	5	2	3	42	1.22000+02	0.00000	0.00000	0.00000	0.00000	2.45768+04	1.00000+00
4	5	2	3	42	5.69000+02	0.00000	0.00000	2.40000+01	0.00000	0.00000	0.00000
1	5	2	3	43	1.04000+00	1.34550+02	2.08550+02	6.78002+05	2.00000+01	1.00000+00	0.00000
2	5	2	3	43	0.00000	0.00000	1.00000+02	1.10000+02	2.10000+00	0.00000	3.64400+01
3	5	2	3	43	1.10000+02	0.00000	0.00000	0.00000	0.00000	2.45768+04	1.00000+00
4	5	2	3	43	4.47000+02	0.00000	0.00000	2.83000+02	0.00000	0.00000	0.00000
1	5	2	3	44	1.03000+00	1.34550+02	2.08550+02	6.78002+05	1.80000+01	1.00000+00	0.00000
2	5	2	3	44	0.00000	0.00000	1.00000+02	1.24500+02	4.20000+00	0.00000	3.44200+01
3	5	2	3	44	1.12000+02	0.00000	2.00000+00	0.00000	0.00000	2.52991+04	2.00000+00
4	5	2	3	44	5.60000+02	0.00000	0.00000	2.30000+01	0.00000	0.00000	0.00000
1	5	2	3	45	1.03000+00	1.34550+02	2.08550+02	6.78002+05	1.80000+01	1.00000+00	0.00000
2	5	2	3	45	0.00000	0.00000	1.00000+02	1.15100+02	2.80000+00	0.00000	3.44200+01
3	5	2	3	45	1.04000+02	0.00000	2.00000+00	0.00000	0.00000	2.52991+04	2.00000+00
4	5	2	3	45	3.75000+02	0.00000	0.00000	2.31000+02	0.00000	0.00000	0.00000
1	6	2	3	46	1.26000+00	0.00000	1.67666+02	2.15003+06	5.40000+01	1.00000+00	1.00000+00
2	6	2	3	46	0.00000	0.00000	9.44000+01	1.19000+02	3.40000+00	0.00000	1.29100+01
3	6	2	3	46	1.19000+02	0.00000	0.00000	0.00000	0.00000	2.36006+04	1.00000+00
4	6	2	3	46	7.41000+02	0.00000	0.00000	2.10000+01	3.28950+03	0.00000	0.00000
1	6	2	3	47	1.29000+00	0.00000	1.67666+02	2.15003+06	5.40000+01	1.00000+00	1.00000+00
2	6	2	3	47	0.00000	0.00000	9.44000+01	1.10000+02	2.00000+00	0.00000	1.28800+01
3	6	2	3	47	1.10000+02	0.00000	0.00000	0.00000	0.00000	2.35377+04	1.00000+00
4	6	2	3	47	6.30000+02	0.00000	0.00000	4.23000+02	0.00000	0.00000	0.00000
1	6	2	3	48	1.24000+00	0.00000	1.67666+02	2.15003+06	5.40000+01	1.00000+00	1.00000+00
2	6	2	3	48	0.00000	0.00000	9.44000+01	1.12000+02	2.30000+00	0.00000	1.39700+01
3	6	2	3	48	1.12000+02	0.00000	0.00000	0.00000	0.00000	2.37334+04	1.00000+00
4	6	2	3	48	6.41000+02	0.00000	0.00000	1.56000+02	0.00000	0.00000	0.00000
1	6	2	3	49	1.23000+00	0.00000	1.61010+02	2.15003+06	4.20000+01	1.00000+00	1.00000+00
2	6	2	3	49	0.00000	0.00000	9.06000+01	1.24900+02	4.30000+00	0.00000	1.17100+01
3	6	2	3	49	1.00000+02	0.00000	1.20000+01	0.00000	0.00000	2.35214+04	2.00000+00
4	6	2	3	49	5.60000+02	0.00000	0.00000	4.00000+01	3.60340+03	0.00000	0.00000
1	6	2	3	50	1.31000+00	0.00000	1.76310+02	2.15003+06	4.20000+01	1.00000+00	1.00000+00
2	6	2	3	50	0.00000	0.00000	9.92000+01	1.17300+02	3.20000+00	0.00000	1.29100+01
3	6	2	3	50	9.10000+01	0.00000	1.20000+01	0.00000	0.00000	2.36006+04	2.00000+00
4	6	2	3	50	4.88000+02	0.00000	0.00000	1.72000+02	0.00000	0.00000	0.00000
1	6	2	3	51	1.26000+00	0.00000	1.33250+02	2.15003+06	4.20000+01	1.00000+00	1.00000+00
2	6	2	3	51	0.00000	0.00000	7.50000+01	1.42500+02	6.50000+00	0.00000	1.40500+01
3	6	2	3	51	1.42500+02	0.00000	0.00000	0.00000	0.00000	2.38196+04	1.00000+00
4	6	2	3	51	8.16000+02	0.00000	0.00000	1.70000+01	0.00000	0.00000	0.00000

TABLE C-2. (Concluded)

HORIZONTALLY OPPOSED COAL FIRED BOILERS

1	6	2	3	52	1.26000+00	0.00000	1.33250+02	2.15003+06	4.20000+01	1.00000+00	1.00000+00
2	6	2	3	52	0.00000	0.00000	7.50000+01	1.42500+02	6.40000+00	0.00000	1.40500+01
3	6	2	3	52	1.10000+02	0.00000	1.20000+01	0.00000	0.00000	2.38196+04	2.00000+00
4	6	2	3	52	8.01000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	3	53	1.26000+00	0.00000	1.30916+02	2.15003+06	4.20000+01	1.00000+00	1.00000+00
2	6	2	3	53	0.00000	0.00000	7.37000+01	1.15900+02	3.00000+00	0.00000	1.40500+01
3	6	2	3	53	9.00000+01	0.00000	1.20000+01	0.00000	0.00000	2.38429+04	2.00000+00
4	6	2	3	53	4.52000+02	0.00000	0.00000	3.30000+01	0.00000	0.00000	0.00000

TABLE C-3. NO_x CONTROL TEST DATA FROM SINGLE WALL COAL-FIRED BOILERS

1	1	3	3	1	1.30000+00	2.26769+02	2.18045+02	3.32262+05	1.60000+01	1.00000+07	1.00000+00
2	1	3	3	1	0.00000	0.00000	1.02400+02	1.20000+02	3.60000+00	0.00000	5.10000+00
3	1	3	3	1	1.20000+02	0.00000	0.00000	0.00000	0.00000	2.81790+04	1.00000+00
4	1	3	3	1	6.56000+02	0.00000	0.00000	5.20000+01	0.00000	7.89000+00	0.00000
1	1	3	3	2	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	3	2	0.00000	0.00000	1.00000+02	1.18000+02	3.30000+00	0.00000	5.40000+00
3	1	3	3	2	1.18000+02	0.00000	0.00000	0.00000	0.00000	2.82070+04	1.00000+00
4	1	3	3	2	6.69000+02	0.00000	0.00000	3.94000+02	8.60000+02	4.65000+00	0.00000
1	1	3	3	3	1.29000+00	2.21490+02	2.12935+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	3	3	0.00000	0.00000	1.00000+02	1.17000+02	3.20000+00	0.00000	6.30000+00
3	1	3	3	3	1.17000+02	0.00000	0.00000	0.00000	0.00000	2.73519+04	1.00000+00
4	1	3	3	3	5.77000+02	0.00000	0.00000	3.29000+02	0.00000	0.00000	0.00000
1	1	3	3	4	1.29000+00	2.21490+02	2.12935+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	3	4	0.00000	0.00000	1.00000+02	1.10000+02	2.00000+00	0.00000	6.30000+00
3	1	3	3	4	1.10000+02	0.00000	0.00000	0.00000	0.00000	2.73519+04	1.00000+00
4	1	3	3	4	4.91000+02	0.00000	0.00000	8.14000+02	0.00000	0.00000	0.00000
1	1	3	3	5	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	1	3	3	5	0.00000	0.00000	1.00000+02	1.23600+02	4.10000+00	0.00000	5.40000+00
3	1	3	3	5	1.07000+02	0.00000	2.00000+00	0.00000	0.00000	2.82070+04	2.00000+00
4	1	3	3	5	5.18000+02	0.00000	0.00000	3.83000+02	1.72000+03	0.00000	0.00000
1	1	3	3	6	1.35000+00	2.12589+02	2.04417+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	1	3	3	6	0.00000	0.00000	9.60000+01	1.14200+02	2.70000+00	0.00000	5.85000+00
3	1	3	3	6	1.00000+02	0.00000	2.00000+00	0.00000	0.00000	2.77783+04	2.00000+00
4	1	3	3	6	3.68000+02	0.00000	0.00000	8.33000+02	0.00000	0.00000	0.00000
1	1	3	3	7	1.37000+00	2.21490+02	2.12935+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	1	3	3	7	0.00000	0.00000	1.00000+02	1.16000+02	3.30000+00	0.00000	7.70000+00
3	1	3	3	7	1.03000+02	0.00000	2.00000+00	0.00000	0.00000	2.83514+04	2.00000+00
4	1	3	3	7	3.97000+02	0.00000	0.00000	4.14000+02	0.00000	5.62000+00	0.00000
1	1	3	3	8	1.43000+00	2.12589+02	2.04417+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	1	3	3	8	0.00000	0.00000	9.60000+01	1.20000+02	3.00000+00	0.00000	7.20000+00
3	1	3	3	8	1.02000+02	0.00000	2.00000+00	0.00000	0.00000	2.94652+04	2.00000+00
4	1	3	3	8	3.43000+02	0.00000	0.00000	8.67000+02	0.00000	3.84000+00	0.00000
1	1	3	3	9	1.31000+00	1.94890+02	1.87383+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	3	9	0.00000	0.00000	8.80000+01	1.29000+02	4.80000+00	0.00000	8.70000+00
3	1	3	3	9	1.29000+02	0.00000	0.00000	0.00000	0.00000	2.81184+04	1.00000+00
4	1	3	3	9	6.29000+02	0.00000	0.00000	5.20000+01	0.00000	0.00000	0.00000
1	1	3	3	10	1.31000+00	1.87853+02	1.80569+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	3	10	0.00000	0.00000	8.48000+01	1.14000+02	2.70000+00	0.00000	8.70000+00
3	1	3	3	10	1.14000+02	0.00000	0.00000	0.00000	0.00000	2.81184+04	1.00000+00
4	1	3	3	10	4.50000+02	0.00000	0.00000	5.30000+02	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	1	3	3	11	1.40000+00	1.94890+02	1.80569+02	3.32262+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	3	11	0.00000	0.00000	8.80000+01	1.26600+02	4.50000+00	0.00000	5.40000+00
3	1	3	3	11	9.40000+01	0.00000	4.00000+00	0.00000	0.00000	2.82070+04	2.00000+00
4	1	3	3	11	4.60000+02	0.00000	0.00000	7.73000+02	0.00000	0.00000	0.00000
1	1	3	3	12	1.35000+00	1.91371+02	1.83976+02	3.32262+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	3	12	0.00000	0.00000	8.64000+01	1.16100+02	3.00000+00	0.00000	5.10000+00
3	1	3	3	12	8.70000+01	0.00000	4.00000+00	0.00000	0.00000	2.81790+04	2.00000+00
4	1	3	3	12	3.45000+02	0.00000	0.00000	1.92000+03	0.00000	0.00000	0.00000
1	2	3	3	13	7.70000-01	1.32376+02	1.06657+02	3.14096+05	1.50000+01	1.00000+00	0.00000
2	2	3	3	13	0.00000	0.00000	9.61900+01	1.30000+02	5.00000+00	0.00000	2.60500+01
3	2	3	3	13	1.30000+02	0.00000	0.00000	0.00000	0.00000	2.31089+04	1.00000+00
4	2	3	3	13	4.54000+02	0.00000	0.00000	1.12000+02	0.00000	0.00000	0.00000
1	2	3	3	14	7.90000-01	1.32376+02	1.06657+02	3.14096+05	1.50000+01	1.00000+00	0.00000
2	2	3	3	14	0.00000	0.00000	9.61900+01	1.25000+02	4.30000+00	0.00000	2.72500+01
3	2	3	3	14	1.25000+02	0.00000	0.00000	0.00000	0.00000	2.39943+04	1.00000+00
4	2	3	3	14	4.09000+02	0.00000	0.00000	7.31000+02	0.00000	0.00000	0.00000
1	2	3	3	15	8.10000-01	1.35067+02	1.08770+02	3.14096+05	1.20000+01	1.00000+00	0.00000
2	2	3	3	15	0.00000	0.00000	9.81000+01	1.27400+02	4.60000+00	0.00000	2.88500+01
3	2	3	3	15	1.02000+02	0.00000	3.00000+00	0.00000	0.00000	2.54925+04	2.00000+00
4	2	3	3	15	3.47000+02	0.00000	0.00000	3.70000+02	0.00000	0.00000	0.00000
1	2	3	3	16	8.40000-01	1.29789+02	1.04543+02	3.14096+05	1.20000+01	1.00000+00	0.00000
2	2	3	3	16	0.00000	0.00000	9.42900+01	1.31900+02	5.20000+00	0.00000	2.75400+01
3	2	3	3	16	8.80000+01	0.00000	6.00000+00	0.00000	0.00000	2.54389+04	2.00000+00
4	2	3	3	16	2.14000+02	0.00000	0.00000	9.62000+02	0.00000	0.00000	0.00000
1	3	3	3	17	1.25000+00	1.67566+02	2.10790+02	6.32587+05	1.60000+01	1.00000+00	0.00000
2	3	3	3	17	0.00000	0.00000	1.00000+02	1.17000+02	3.20000+00	0.00000	1.59700+01
3	3	3	3	17	1.17000+02	0.00000	0.00000	0.00000	0.00000	2.89293+04	1.00000+00
4	3	3	3	17	6.70000+02	0.00000	0.00000	6.90000+01	0.00000	0.00000	0.00000
1	3	3	3	18	1.27000+00	1.64358+02	2.06657+02	6.32587+05	1.60000+01	1.00000+00	0.00000
2	3	3	3	18	0.00000	0.00000	9.80500+01	1.07000+02	1.50000+00	0.00000	1.56000+01
3	3	3	3	18	1.07000+02	0.00000	0.00000	0.00000	0.00000	2.91623+04	1.00000+00
4	3	3	3	18	5.56000+02	0.00000	0.00000	9.30000+01	0.00000	0.00000	0.00000
1	3	3	3	19	1.20000+00	1.66946+02	2.09970+02	6.32587+05	1.40000+01	1.00000+00	0.00000
2	3	3	3	19	0.00000	0.00000	9.96100+01	1.21400+02	3.80000+00	0.00000	1.70700+01
3	3	3	3	19	1.06000+02	0.00000	2.00000+00	0.00000	0.00000	2.86101+04	2.00000+00
4	3	3	3	19	6.44000+02	0.00000	0.00000	1.80000+01	0.00000	0.00000	0.00000
1	3	3	3	20	1.26000+00	1.59080+02	2.00064+02	6.32587+05	1.40000+01	1.00000+00	0.00000
2	3	3	3	20	0.00000	0.00000	9.49200+01	1.10300+02	2.00000+00	0.00000	1.65500+01
3	3	3	3	20	9.60000+01	0.00000	2.00000+00	0.00000	0.00000	2.91832+04	2.00000+00
4	3	3	3	20	4.74000+02	0.00000	0.00000	2.00000+02	0.00000	0.00000	0.00000

FRONT WALL COAL FIRED BOILERS

1	3	3	3	21	1.23600+00	1.38690+02	1.74575+02	7.38067+05	1.60000+01	1.00000+00	0.00000
2	3	3	3	21	0.00000	0.00000	8.28100+01	1.24000+02	4.20000+00	0.00000	1.59400+01
3	3	3	3	21	1.24000+02	0.00000	0.00000	0.00000	0.00000	2.93161+04	1.00000+00
4	3	3	3	21	6.68000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	3	22	1.25000+00	1.33618+02	1.67982+02	7.38067+05	1.60000+01	1.00000+00	0.00000
2	3	3	3	22	0.00000	0.00000	7.96900+01	1.08000+02	1.60000+00	0.00000	1.60400+01
3	3	3	3	22	1.08000+02	0.00000	0.00000	0.00000	0.00000	2.93370+04	1.00000+00
4	3	3	3	22	5.16000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	3	23	1.33000+00	1.97685+02	4.55523+02	8.84274+05	1.60000+01	1.00000+00	0.00000
2	4	3	3	23	0.00000	0.00000	1.00000+02	1.20000+02	3.60000+00	0.00000	9.60000+00
3	4	3	3	23	1.20000+02	0.00000	0.00000	0.00000	0.00000	2.88314+04	1.00000+00
4	4	3	3	23	8.50500+02	0.00000	0.00000	2.25000+01	0.00000	0.00000	0.00000
1	4	3	3	24	1.33000+00	1.97685+02	4.55523+02	8.84274+05	1.60000+01	1.00000+00	0.00000
2	4	3	3	24	0.00000	0.00000	1.00000+02	1.12000+02	2.40000+00	0.00000	9.60000+00
3	4	3	3	24	1.12000+02	0.00000	0.00000	0.00000	0.00000	2.88314+04	1.00000+00
4	4	3	3	24	7.17000+02	0.00000	0.00000	1.10000+02	0.00000	0.00000	0.00000
1	4	3	3	25	1.33000+00	1.97685+02	4.55523+02	8.84274+05	1.40000+01	1.00000+00	0.00000
2	4	3	3	25	0.00000	0.00000	1.00000+02	1.18300+02	3.40000+00	0.00000	9.60000+00
3	4	3	3	25	1.04000+02	0.00000	2.00000+00	0.00000	0.00000	2.88314+04	2.00000+00
4	4	3	3	25	6.46500+02	0.00000	0.00000	3.30000+01	0.00000	0.00000	0.00000
1	4	3	3	26	1.43000+00	1.96443+02	4.36911+02	8.84274+05	1.40000+01	1.00000+00	0.00000
2	4	3	3	26	0.00000	0.00000	9.93800+01	1.14100+02	2.70000+00	0.00000	8.13000+00
3	4	3	3	26	1.01000+02	0.00000	2.00000+00	0.00000	0.00000	3.02294+04	2.00000+00
4	4	3	3	26	5.31000+02	0.00000	0.00000	4.00000+01	0.00000	0.00000	0.00000
1	4	3	3	27	1.37000+00	1.68084+02	3.87194+02	8.84274+05	1.60000+01	1.00000+00	0.00000
2	4	3	3	27	0.00000	0.00000	8.50000+01	1.21000+02	3.80000+00	0.00000	9.36000+00
3	4	3	3	27	1.21000+02	0.00000	0.00000	0.00000	0.00000	2.97122+04	1.00000+00
4	4	3	3	27	7.94000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	3	28	1.37000+00	1.68084+02	3.87194+02	8.84274+05	1.60000+01	1.00000+00	0.00000
2	4	3	3	28	0.00000	0.00000	8.50000+01	1.05000+02	2.10000+00	0.00000	9.36000+00
3	4	3	3	28	1.05000+02	0.00000	0.00000	0.00000	0.00000	2.97122+04	1.00000+00
4	4	3	3	28	6.97000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	3	29	1.37000+00	1.54422+02	3.55901+02	8.84274+05	1.20000+01	1.00000+00	0.00000
2	4	3	3	29	0.00000	0.00000	7.81300+01	1.20900+02	3.75000+00	0.00000	9.36000+00
3	4	3	3	29	9.05000+01	0.00000	4.00000+00	0.00000	0.00000	2.97122+04	2.00000+00
4	4	3	3	29	5.36000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	3	30	1.37000+00	1.68084+02	3.87194+02	8.84274+05	1.20000+01	1.00000+00	0.00000
2	4	3	3	30	0.00000	0.00000	8.50000+01	1.16900+02	3.15000+00	0.00000	9.36000+00
3	4	3	3	30	8.60000+01	0.00000	4.00000+00	0.00000	0.00000	2.97122+04	2.00000+00
4	4	3	3	30	5.16000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	4	3	3	31	1.37000+00	1.66842+02	3.84355+02	8.84274+05	1.20000+01	1.00000+00	0.00000
2	4	3	3	31	0.00000	0.00000	8.43800+01	1.16000+02	2.95000+00	0.00000	9.36000+00
3	4	3	3	31	8.75000+01	0.00000	4.00000+00	0.00000	0.00000	2.97122+04	2.00000+00
4	4	3	3	31	5.29000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	37	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	3	37	0.00000	0.00000	1.00000+02	1.22000+02	4.00000+00	0.00000	7.08000+00
3	6	3	3	37	1.22000+02	0.00000	0.00000	0.00000	0.00000	2.83468+04	1.00000+00
4	6	3	3	37	5.94000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	38	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	3	38	0.00000	0.00000	1.00000+02	1.15000+02	2.90000+00	0.00000	7.08000+00
3	6	3	3	38	1.15000+02	0.00000	0.00000	0.00000	0.00000	2.83468+04	1.00000+00
4	6	3	3	38	5.06000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	39	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	6	3	3	39	0.00000	0.00000	1.00000+02	1.26000+02	4.55000+00	0.00000	7.08000+00
3	6	3	3	39	1.10000+02	0.00000	2.00000+00	0.00000	0.00000	2.83468+04	2.00000+00
4	6	3	3	39	5.23000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	40	1.40000+00	2.21490+02	2.12935+02	3.32262+05	1.40000+01	1.00000+00	1.00000+00
2	6	3	3	40	0.00000	0.00000	1.00000+02	1.17000+02	3.15000+00	0.00000	7.08000+00
3	6	3	3	40	1.02000+02	0.00000	2.00000+00	0.00000	0.00000	2.83468+04	2.00000+00
4	6	3	3	40	3.38000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	41	1.40000+00	1.94890+02	1.87383+02	3.32262+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	3	41	0.00000	0.00000	8.80000+01	1.15000+02	2.90000+00	0.00000	7.08000+00
3	6	3	3	41	1.15000+02	0.00000	0.00000	0.00000	0.00000	2.83468+04	1.00000+00
4	6	3	3	41	4.62000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	3	42	1.40000+00	1.94890+02	1.87383+02	3.32262+05	1.20000+01	1.00000+00	1.00000+00
2	6	3	3	42	0.00000	0.00000	8.80000+01	1.15000+02	2.90000+00	0.00000	7.08000+00
3	6	3	3	42	8.60000+01	0.00000	4.00000+00	0.00000	0.00000	2.83468+04	2.00000+00
4	6	3	3	42	2.98000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	3	3	46	1.36000+00	1.95201+02	2.89371+02	4.93705+05	1.60000+01	1.00000+00	1.00000+00
2	8	3	3	46	0.00000	0.00000	8.05700+01	1.23800+02	4.10000+00	0.00000	9.40000+00
3	8	3	3	46	1.23800+02	0.00000	0.00000	0.00000	0.00000	2.82163+04	1.00000+00
4	8	3	3	46	6.01000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	8	3	3	47	1.36000+00	1.93855+02	2.87320+02	4.93705+05	1.60000+01	1.00000+00	1.00000+00
2	8	3	3	47	0.00000	0.00000	8.00000+01	1.16400+02	3.00000+00	0.00000	9.70000+00
3	8	3	3	47	1.16400+02	0.00000	0.00000	0.00000	0.00000	2.82396+04	1.00000+00
4	8	3	3	47	5.27000+02	0.00000	0.00000	9.60000+01	0.00000	0.00000	0.00000
1	8	3	3	48	1.36000+00	1.93855+02	2.87320+02	4.93705+05	1.20000+01	1.00000+00	1.00000+00
2	8	3	3	48	0.00000	0.00000	8.00000+01	1.30000+02	5.00000+00	0.00000	9.30000+00
3	8	3	3	48	9.70000+01	0.00000	4.00000+00	0.00000	0.00000	2.80994+04	2.00000+00
4	8	3	3	48	3.50000+02	0.00000	0.00000	6.20000+01	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	8	3	3	49	1.36000+00	1.91061+02	2.83219+02	4.93705+05	1.20000+01	1.00000+00	1.00000+00
2	8	3	3	49	0.00000	0.00000	7.88600+01	1.18100+02	3.30000+00	0.00000	9.90000+00
3	8	3	3	49	8.90000+01	0.00000	4.00000+00	0.00000	0.00000	2.79833+04	2.00000+00
4	8	3	3	49	3.00000+02	0.00000	0.00000	2.58000+02	0.00000	0.00000	0.00000
1	8	3	3	50	1.36000+00	1.99341+02	2.95554+02	4.93705+05	1.20000+01	1.00000+00	1.00000+00
2	8	3	3	50	0.00000	0.00000	8.22900+01	1.15100+02	2.80000+00	0.00000	9.40000+00
3	8	3	3	50	8.60000+01	0.00000	4.00000+00	0.00000	0.00000	2.80532+04	2.00000+00
4	8	3	3	50	2.25000+02	0.00000	0.00000	5.58000+02	0.00000	0.00000	0.00000
1	9	3	3	51	1.29000+00	1.51007+02	2.10695+02	8.86032+05	2.40000+01	2.00000+00	0.00000
2	9	3	3	51	0.00000	0.00000	8.34900+01	1.33700+02	5.40000+00	0.00000	7.21000+00
3	9	3	3	51	1.33700+02	0.00000	0.00000	0.00000	0.00000	3.23404+04	1.00000+00
4	9	3	3	51	1.48000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9	3	3	52	1.29000+00	1.57941+02	2.20317+02	8.86032+05	2.40000+01	2.00000+00	0.00000
2	9	3	3	52	0.00000	0.00000	8.73000+01	1.19500+02	3.50000+00	0.00000	7.21000+00
3	9	3	3	52	1.19500+02	0.00000	0.00000	0.00000	0.00000	3.23404+04	1.00000+00
4	9	3	3	52	1.49000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9	3	3	53	1.29000+00	9.19080+01	1.28171+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	9	3	3	53	0.00000	0.00000	5.07900+01	1.53000+02	7.50000+00	0.00000	7.21000+00
3	9	3	3	53	1.53000+02	0.00000	0.00000	0.00000	0.00000	3.23404+04	1.00000+00
4	9	3	3	53	1.20000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9	3	3	54	1.29000+00	9.19080+01	1.28171+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	9	3	3	54	0.00000	0.00000	5.07900+01	1.36000+02	5.70000+00	0.00000	7.21000+00
3	9	3	3	54	1.36000+02	0.00000	0.00000	0.00000	0.00000	3.23404+04	1.00000+00
4	9	3	3	54	1.16000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9	3	3	55	1.29000+00	1.06812+02	1.49023+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	9	3	3	55	0.00000	0.00000	5.90500+01	1.43100+02	6.50000+00	0.00000	7.21000+00
3	9	3	3	55	9.54000+01	0.00000	8.00000+00	0.00000	0.00000	3.21540+04	2.10000+00
4	9	3	3	55	1.28000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9	3	3	56	1.29000+00	1.10849+02	1.54638+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	9	3	3	56	0.00000	0.00000	6.12700+01	1.27100+02	4.60000+00	0.00000	7.21000+00
3	9	3	3	56	8.47000+01	0.00000	8.00000+00	0.00000	0.00000	3.23404+04	2.10000+00
4	9	3	3	56	1.19000+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	3	3	57	1.50000+00	2.13624+02	1.94323+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	57	0.00000	0.00000	9.60000+01	1.17000+02	3.20000+00	0.00000	8.90000+00
3	10	3	3	57	1.17000+02	0.00000	0.00000	0.00000	0.00000	2.44067+04	1.00000+00
4	10	3	3	57	5.82500+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	10	3	3	53	1.30000+00	2.23974+02	2.04039+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	53	0.00000	0.00000	1.00800+02	1.10000+02	2.00000+00	0.00000	6.10000+00
3	10	3	3	53	1.10000+02	0.00000	0.00000	0.00000	0.00000	2.65853+04	1.00000+00
4	10	3	3	53	4.60000+02	0.00000	0.00000	6.80000+02	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	10	3	3	59	1.30000+00	2.20765+02	2.00790+02	3.47791+05	1.40000+01	1.00000+00	1.00000+00
2	10	3	3	59	0.00000	0.00000	9.92000+01	1.18500+02	3.30000+00	0.00000	7.30000+00
3	10	3	3	59	1.03000+02	0.00000	2.00000+00	0.00000	0.00000	2.76385+04	2.00000+00
4	10	3	3	59	5.01500+02	0.00000	0.00000	1.53000+02	0.00000	0.00000	0.00000
1	10	3	3	60	1.30000+00	2.22525+02	2.02399+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	60	0.00000	0.00000	1.00000+02	1.13000+02	2.50000+00	0.00000	6.70000+00
3	10	3	3	60	1.13000+02	0.00000	0.00000	0.00000	0.00000	2.63523+04	1.00000+00
4	10	3	3	60	5.02000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	3	3	61	1.30000+00	2.19006+02	1.99181+02	3.47791+05	1.40000+01	1.00000+00	1.00000+00
2	10	3	3	61	0.00000	0.00000	9.84000+01	1.15100+02	2.80000+00	0.00000	7.10000+00
3	10	3	3	61	1.02000+02	0.00000	2.00000+00	0.00000	0.00000	2.78132+04	2.00000+00
4	10	3	3	61	4.40500+02	0.00000	0.00000	4.24000+02	0.00000	0.00000	0.00000
1	10	3	3	62	1.30000+00	1.76260+02	1.60316+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	62	0.00000	0.00000	7.92000+01	1.16000+02	3.00000+00	0.00000	7.50000+00
3	10	3	3	62	1.16000+02	0.00000	0.00000	0.00000	0.00000	2.74031+04	1.00000+00
4	10	3	3	62	5.26000+02	0.00000	0.00000	3.90000+01	0.00000	0.00000	0.00000
1	10	3	3	63	1.30000+00	1.76260+02	1.60316+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	63	0.00000	0.00000	7.92000+01	1.14000+02	2.65000+00	0.00000	7.70000+00
3	10	3	3	63	1.14000+02	0.00000	0.00000	0.00000	0.00000	2.67927+04	1.00000+00
4	10	3	3	63	4.46500+02	0.00000	0.00000	6.80000+01	0.00000	0.00000	0.00000
1	10	3	3	64	1.30000+00	1.81539+02	1.65174+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	64	0.00000	0.00000	8.16000+01	1.23200+02	4.00000+00	0.00000	6.60000+00
3	10	3	3	64	1.17000+02	0.00000	4.00000+00	0.00000	0.00000	2.72284+04	2.00000+00
4	10	3	3	64	4.70500+02	0.00000	0.00000	4.00000+01	0.00000	0.00000	0.00000
1	10	3	3	65	1.20000+00	1.78020+02	1.61610+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	65	0.00000	0.00000	8.00000+01	1.14600+02	2.80000+00	0.00000	5.10000+00
3	10	3	3	65	1.13000+02	0.00000	4.00000+00	0.00000	0.00000	2.70140+04	2.00000+00
4	10	3	3	65	3.68000+02	0.00000	0.00000	5.84000+02	0.00000	0.00000	0.00000
1	10	3	3	66	1.30000+00	8.54910+01	7.77291+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	66	0.00000	0.00000	3.84000+01	1.73000+02	9.00000+00	0.00000	1.18000+01
3	10	3	3	66	1.73000+02	0.00000	0.00000	0.00000	0.00000	2.59888+04	1.00000+00
4	10	3	3	66	6.04000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	10	3	3	67	1.40000+00	8.54910+01	7.77291+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	67	0.00000	0.00000	3.84000+01	1.63000+02	8.20000+00	0.00000	1.10000+01
3	10	3	3	67	1.63000+02	0.00000	0.00000	0.00000	0.00000	3.28530+04	1.00000+00
4	10	3	3	67	5.69000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	10	3	3	68	1.20000+00	8.90100+01	8.09468+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	68	0.00000	0.00000	4.00000+01	1.85000+02	9.60000+00	0.00000	9.80000+00
3	10	3	3	68	1.85000+02	0.00000	0.00000	0.00000	0.00000	2.57651+04	1.00000+00
4	10	3	3	68	5.59500+02	0.00000	0.00000	5.10000+01	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	10	3	3	69	1.10000+00	8.90100+01	8.09468+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	69	0.00000	0.00000	4.00000+01	1.57000+02	7.80000+00	0.00000	7.80000+00
3	10	3	3	69	1.57000+02	0.00000	0.00000	0.00000	0.00000	2.54063+04	1.00000+00
4	10	3	3	69	4.57500+02	0.00000	0.00000	4.40000+01	0.00000	0.00000	0.00000
1	10	3	3	70	1.30000+00	8.36280+01	7.60887+01	3.47791+05	6.00000+00	1.00000+00	1.00000+00
2	10	3	3	70	0.00000	0.00000	3.76000+01	1.90900+02	1.00000+01	0.00000	8.00000+00
3	10	3	3	70	1.61000+02	0.00000	2.00000+00	0.00000	0.00000	2.87056+04	2.00000+00
4	10	3	3	70	3.79500+02	0.00000	0.00000	7.80000+01	0.00000	0.00000	0.00000
1	10	3	3	71	1.30000+00	8.36280+01	7.60887+01	3.47791+05	6.00000+00	1.00000+00	1.00000+00
2	10	3	3	71	0.00000	0.00000	3.76000+01	1.60400+02	8.10000+00	0.00000	7.00000+00
3	10	3	3	71	1.40000+02	0.00000	2.00000+00	0.00000	0.00000	2.82606+04	2.00000+00
4	10	3	3	71	3.25500+02	0.00000	0.00000	6.10000+01	0.00000	0.00000	0.00000
1	10	3	3	72	1.20000+00	1.33515+02	1.21452+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	72	0.00000	0.00000	6.00000+01	1.51000+02	7.10000+00	0.00000	6.50000+00
3	10	3	3	72	1.51000+02	0.00000	0.00000	0.00000	0.00000	2.73822+04	1.00000+00
4	10	3	3	72	5.05000+02	0.00000	0.00000	4.20000+01	0.00000	0.00000	0.00000
1	10	3	3	73	1.30000+00	1.31755+02	1.19811+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	73	0.00000	0.00000	5.92000+01	1.28000+02	4.60000+00	0.00000	6.20000+00
3	10	3	3	73	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.73915+04	1.00000+00
4	10	3	3	73	3.91000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	3	3	74	1.30000+00	1.33515+02	1.21452+02	3.47791+05	1.00000+01	1.00000+00	1.00000+00
2	10	3	3	74	0.00000	0.00000	6.00000+01	1.52000+02	7.20000+00	0.00000	6.20000+00
3	10	3	3	74	1.29000+02	0.00000	2.00000+00	0.00000	0.00000	2.80136+04	2.00000+00
4	10	3	3	74	4.93500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	3	3	75	1.30000+00	1.29996+02	1.18203+02	3.47791+05	1.00000+01	1.00000+00	1.00000+00
2	10	3	3	75	0.00000	0.00000	5.84000+01	1.25100+02	4.40000+00	0.00000	6.20000+00
3	10	3	3	75	1.17000+02	0.00000	2.00000+00	0.00000	0.00000	2.73915+04	2.00000+00
4	10	3	3	75	3.33500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	10	3	3	76	1.40000+00	2.22525+02	2.02399+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	76	0.00000	0.00000	1.00000+02	1.28000+02	4.60000+00	0.00000	6.20000+00
3	10	3	3	76	1.28000+02	0.00000	0.00000	0.00000	0.00000	2.82443+04	1.00000+00
4	10	3	3	76	6.23000+02	0.00000	0.00000	0.00000	0.00000	2.93000+00	0.00000
1	10	3	3	77	1.40000+00	2.34945+02	2.13755+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	77	0.00000	0.00000	1.05600+02	1.22000+02	3.70000+00	0.00000	8.70000+00
3	10	3	3	77	1.22000+02	0.00000	0.00000	0.00000	0.00000	3.04950+04	1.00000+00
4	10	3	3	77	5.72000+02	0.00000	0.00000	0.00000	0.00000	4.59000+00	0.00000
1	10	3	3	78	1.30000+00	2.20765+02	2.00790+02	3.47791+05	1.40000+01	1.00000+00	1.00000+00
2	10	3	3	78	0.00000	0.00000	9.92000+01	1.22000+02	3.70000+00	0.00000	9.20000+00
3	10	3	3	78	1.07000+02	0.00000	2.00000+00	0.00000	0.00000	3.03523+04	2.00000+00
4	10	3	3	78	3.91000+02	0.00000	0.00000	0.00000	0.00000	1.10500+01	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	10	3	3	79	1.40000+00	2.20765+02	2.00790+02	3.47791+05	1.40000+01	1.00000+00	1.00000+00
2	10	3	3	79	0.00000	0.00000	9.92000+01	1.15000+02	2.90000+00	0.00000	5.70000+00
3	10	3	3	79	1.01000+02	0.00000	2.00000+00	0.00000	0.00000	2.68999+04	2.00000+00
4	10	3	3	79	3.76000+02	0.00000	0.00000	0.00000	0.00000	8.78000+00	0.00000
1	10	3	3	80	1.20000+00	1.81539+02	1.65174+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	80	0.00000	0.00000	8.16000+01	1.47000+02	6.70000+00	0.00000	5.70000+00
3	10	3	3	80	1.47000+02	0.00000	0.00000	0.00000	0.00000	2.84423+04	1.00000+00
4	10	3	3	80	6.95000+02	0.00000	0.00000	0.00000	0.00000	1.02100+01	0.00000
1	10	3	3	81	1.20000+00	1.85472+02	1.70032+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	10	3	3	81	0.00000	0.00000	8.40000+01	1.38000+02	5.70000+00	0.00000	6.50000+00
3	10	3	3	81	1.38000+02	0.00000	0.00000	0.00000	0.00000	2.76967+04	1.00000+00
4	10	3	3	81	6.01000+02	0.00000	0.00000	0.00000	0.00000	1.01800+01	0.00000
1	10	3	3	82	1.30000+00	1.74501+02	1.58676+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	82	0.00000	0.00000	7.84000+01	1.39000+02	5.70000+00	0.00000	7.10000+00
3	10	3	3	82	1.04000+02	0.00000	4.00000+00	0.00000	0.00000	2.78482+04	2.00000+00
4	10	3	3	82	3.98000+02	0.00000	0.00000	0.00000	0.00000	1.03100+01	0.00000
1	10	3	3	83	1.30000+00	1.76260+02	1.60316+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	83	0.00000	0.00000	7.92000+01	1.35000+02	5.30000+00	0.00000	7.90000+00
3	10	3	3	83	1.01000+02	0.00000	4.00000+00	0.00000	0.00000	2.84377+04	2.00000+00
4	10	3	3	83	3.91000+02	0.00000	0.00000	0.00000	0.00000	1.03800+01	0.00000
1	10	3	3	84	1.30000+00	1.33515+02	1.21452+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	84	0.00000	0.00000	6.00000+01	1.68000+02	8.50000+00	0.00000	7.10000+00
3	10	3	3	84	1.68000+02	0.00000	0.00000	0.00000	0.00000	2.84120+04	1.00000+00
4	10	3	3	84	5.64000+02	0.00000	0.00000	0.00000	0.00000	7.27000+00	0.00000
1	10	3	3	85	1.30000+00	1.35274+02	6.72243+01	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	10	3	3	85	0.00000	0.00000	6.08000+01	1.56000+02	7.50000+00	0.00000	8.20000+00
3	10	3	3	85	1.56000+02	0.00000	0.00000	0.00000	0.00000	2.82792+04	1.00000+00
4	10	3	3	85	4.27000+02	0.00000	0.00000	0.00000	0.00000	4.67000+00	0.00000
1	10	3	3	86	1.30000+00	1.29996+02	1.18203+02	3.47791+05	1.00000+01	1.00000+00	1.00000+00
2	10	3	3	86	0.00000	0.00000	5.84000+01	1.51000+02	7.00000+00	0.00000	1.06000+01
3	10	3	3	86	1.26000+02	0.00000	2.00000+00	0.00000	0.00000	2.82769+04	2.00000+00
4	10	3	3	86	3.62000+02	0.00000	0.00000	0.00000	0.00000	6.71000+00	0.00000
1	10	3	3	87	1.30000+00	1.29996+02	1.18203+02	3.47791+05	1.00000+01	1.00000+00	1.00000+00
2	10	3	3	87	0.00000	0.00000	5.84000+01	1.46000+02	6.60000+00	0.00000	9.90000+00
3	10	3	3	87	1.22000+02	0.00000	2.00000+00	0.00000	0.00000	2.78784+04	2.00000+00
4	10	3	3	87	3.62000+02	0.00000	0.00000	0.00000	0.00000	9.26000+00	0.00000
1	10	3	3	88	1.30000+00	8.36280+01	7.60887+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	88	0.00000	0.00000	3.76000+01	1.85000+02	9.60000+00	0.00000	4.50000+00
3	10	3	3	88	1.85000+02	0.00000	0.00000	0.00000	0.00000	2.96726+04	1.00000+00
4	10	3	3	88	3.69000+02	0.00000	0.00000	0.00000	0.00000	4.88000+00	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	10	3	3	89	1.30000+00	8.36280+01	7.60887+01	3.47791+05	8.00000+00	1.00000+00	1.00000+00
2	10	3	3	89	0.00000	0.00000	3.76000+01	1.74000+02	9.10000+00	0.00000	4.90000+00
3	10	3	3	89	1.74000+02	0.00000	0.00000	0.00000	0.00000	2.98496+04	1.00000+00
4	10	3	3	89	3.11000+02	0.00000	0.00000	0.00000	0.00000	4.52000+00	0.00000
1	10	3	3	90	1.30000+00	9.25290+01	8.41960+01	3.47791+05	6.00000+00	1.00000+00	1.00000+00
2	10	3	3	90	0.00000	0.00000	4.16000+01	1.55000+02	9.10000+00	0.00000	9.30000+00
3	10	3	3	90	1.16000+02	0.00000	2.00000+00	0.00000	0.00000	2.84819+04	2.00000+00
4	10	3	3	90	2.67000+02	0.00000	0.00000	0.00000	0.00000	5.71000+00	0.00000
1	10	3	3	91	1.30000+00	9.43920+01	8.58049+01	3.47791+05	6.00000+00	1.00000+00	1.00000+00
2	10	3	3	91	0.00000	0.00000	4.24000+01	1.45000+02	8.30000+00	0.00000	9.50000+00
3	10	3	3	91	1.09000+02	0.00000	2.00000+00	0.00000	0.00000	2.91110+04	2.00000+00
4	10	3	3	91	2.75000+02	0.00000	0.00000	0.00000	0.00000	5.11000+00	0.00000
1	11	3	3	92	1.21000+00	2.15383+02	1.95932+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	92	0.00000	0.00000	9.68000+01	1.23000+02	4.00000+00	0.00000	1.07500+01
3	11	3	3	92	1.23000+02	0.00000	0.00000	0.00000	0.00000	2.79903+04	1.00000+00
4	11	3	3	92	5.97000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	11	3	3	93	1.21000+00	2.10105+02	1.91074+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	93	0.00000	0.00000	9.44000+01	1.17000+02	3.20000+00	0.00000	1.07500+01
3	11	3	3	93	1.17000+02	0.00000	0.00000	0.00000	0.00000	2.79903+04	1.00000+00
4	11	3	3	93	5.02000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	11	3	3	94	1.21000+00	2.22525+02	2.02399+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	94	0.00000	0.00000	1.00000+02	1.13000+02	2.50000+00	0.00000	1.01800+01
3	11	3	3	94	1.13000+02	0.00000	0.00000	0.00000	0.00000	2.66272+04	1.00000+00
4	11	3	3	94	4.41000+02	0.00000	0.00000	0.00000	0.00000	7.48000+00	0.00000
1	11	3	3	95	1.21000+00	2.22525+02	2.02399+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	95	0.00000	0.00000	1.00000+02	1.12000+02	2.40000+00	0.00000	8.40000+00
3	11	3	3	95	1.12000+02	0.00000	0.00000	0.00000	0.00000	2.86963+04	1.00000+00
4	11	3	3	95	4.09000+02	0.00000	0.00000	0.00000	0.00000	7.46000+00	0.00000
1	11	3	3	96	1.21000+00	2.15383+02	1.95932+02	3.47791+05	1.40000+01	1.00000+00	1.00000+00
2	11	3	3	96	0.00000	0.00000	9.68000+01	1.15000+02	3.00000+00	0.00000	1.07500+01
3	11	3	3	96	1.01000+02	0.00000	2.00000+00	0.00000	0.00000	2.79903+04	2.00000+00
4	11	3	3	96	4.86000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	11	3	3	97	1.21000+00	1.81539+02	1.65143+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	97	0.00000	0.00000	8.16000+01	1.35000+02	5.50000+00	0.00000	1.07500+01
3	11	3	3	97	1.35000+02	0.00000	0.00000	0.00000	0.00000	2.79903+04	1.00000+00
4	11	3	3	97	6.60000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	11	3	3	98	1.21000+00	1.74501+02	1.58676+02	3.47791+05	1.60000+01	1.00000+00	1.00000+00
2	11	3	3	98	0.00000	0.00000	7.84000+01	1.16000+02	3.00000+00	0.00000	1.07500+01
3	11	3	3	98	1.16000+02	0.00000	0.00000	0.00000	0.00000	2.79903+04	1.00000+00
4	11	3	3	98	4.62000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-3. (Continued)

FRONT WALL COAL FIRED BOILERS

1	11	3	3	99	1.21000+00	1.76260+02	1.60285+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	11	3	3	99	0.00000	0.00000	7.92000+01	1.25000+02	4.50000+00	0.00000	1.07500+01
3	11	3	3	99	9.40000+01	0.00000	4.00000+00	0.00000	0.00000	2.79903+04	2.00000+00
4	11	3	3	99	3.29000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	11	3	3	100	1.21000+00	1.79779+02	1.63534+02	3.47791+05	1.20000+01	1.00000+00	1.00000+00
2	11	3	3	100	0.00000	0.00000	8.08000+01	1.17000+02	3.30000+00	0.00000	1.07500+01
3	11	3	3	100	8.80000+01	0.00000	4.00000+00	0.00000	0.00000	2.79903+04	2.00000+00
4	11	3	3	100	3.02000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	101	1.53000+00	1.56492+02	1.59023+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	101	0.00000	0.00000	1.09600+02	1.22000+02	3.90000+00	0.00000	6.02000+00
3	12	3	3	101	1.22000+02	0.00000	0.00000	0.00000	0.00000	3.21983+04	1.00000+00
4	12	3	3	101	1.38300+03	0.00000	0.00000	0.00000	1.12660+03	0.00000	0.00000
1	12	3	3	102	1.53000+00	1.53387+02	1.55837+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	102	0.00000	0.00000	1.07400+02	1.09400+02	1.86000+00	0.00000	6.02000+00
3	12	3	3	102	1.09400+02	0.00000	0.00000	0.00000	0.00000	3.21983+04	1.00000+00
4	12	3	3	102	1.14700+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	103	1.52000+00	1.53387+02	1.55837+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	103	0.00000	0.00000	1.07400+02	1.23500+02	4.10000+00	0.00000	6.32000+00
3	12	3	3	103	1.23500+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	103	1.31900+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	104	1.52000+00	1.48108+02	1.50442+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	104	0.00000	0.00000	1.03700+02	1.29500+02	4.90000+00	0.00000	6.32000+00
3	12	3	3	104	1.29500+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	104	1.25600+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	105	1.52000+00	7.99020+01	8.11361+01	7.80259+05	1.80000+01	2.00000+00	0.00000
2	12	3	3	105	0.00000	0.00000	5.59300+01	1.14200+02	6.60000+00	0.00000	6.32000+00
3	12	3	3	105	1.44200+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	105	9.06000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	106	1.52000+00	7.99020+01	8.11361+01	7.80259+05	1.80000+01	2.00000+00	0.00000
2	12	3	3	106	0.00000	0.00000	5.59300+01	1.30000+02	4.98000+00	0.00000	6.32000+00
3	12	3	3	106	1.30000+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	106	7.78000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	107	1.52000+00	8.01090+01	8.14200+01	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	107	0.00000	0.00000	5.61200+01	1.62900+02	8.21000+00	0.00000	6.32000+00
3	12	3	3	107	1.08000+02	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	107	7.71000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	108	1.52000+00	8.01090+01	8.14200+01	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	108	0.00000	0.00000	5.61200+01	1.25000+02	4.28000+00	0.00000	6.32000+00
3	12	3	3	108	8.30000+01	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	108	3.41000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-3. (Concluded)

FRONT WALL COAL FIRED BOILERS

1	12	3	3	109	1.52000+00	1.15299+02	1.17130+02	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	109	0.00000	0.00000	8.07400+01	1.46000+02	6.78000+00	0.00000	6.32000+00
3	12	3	3	109	9.73000+01	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	109	7.69000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	110	1.52000+00	1.15299+02	1.17130+02	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	110	0.00000	0.00000	8.07400+01	1.20000+02	3.60000+00	0.00000	6.32000+00
3	12	3	3	110	8.00000+01	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	110	3.86000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	111	1.52000+00	1.25856+02	1.27887+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	111	0.00000	0.00000	8.81500+01	1.38000+02	5.86000+00	0.00000	6.32000+00
3	12	3	3	111	1.38000+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	111	1.13600+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	112	1.52000+00	1.22751+02	1.24669+02	7.80259+05	2.40000+01	2.00000+00	0.00000
2	12	3	3	112	0.00000	0.00000	8.59300+01	1.17000+02	3.15000+00	0.00000	6.32000+00
3	12	3	3	112	1.17000+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	112	1.01900+03	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	113	1.52000+00	1.19542+02	1.21452+02	7.80259+05	1.80000+01	2.00000+00	0.00000
2	12	3	3	113	0.00000	0.00000	8.37000+01	1.17500+02	3.22000+00	0.00000	6.32000+00
3	12	3	3	113	1.17500+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	113	9.36000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	114	1.52000+00	8.72505+01	8.86755+01	7.80259+05	1.80000+01	2.00000+00	0.00000
2	12	3	3	114	0.00000	0.00000	6.11100+01	1.23000+02	4.00000+00	0.00000	6.32000+00
3	12	3	3	114	1.23000+02	0.00000	0.00000	0.00000	0.00000	3.19117+04	1.00000+00
4	12	3	3	114	7.14000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	115	1.52000+00	8.56980+01	8.70667+01	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	115	0.00000	0.00000	6.00000+01	1.49000+02	7.02000+00	0.00000	6.32000+00
3	12	3	3	115	9.93000+01	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	115	6.89000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	12	3	3	116	1.52000+00	8.56980+01	8.70667+01	7.80259+05	1.60000+01	2.00000+00	0.00000
2	12	3	3	116	0.00000	0.00000	6.00000+01	1.23000+02	4.16000+00	0.00000	6.32000+00
3	12	3	3	116	8.20000+01	0.00000	8.00000+00	0.00000	0.00000	3.19117+04	2.00000+00
4	12	3	3	116	3.62000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-4. NO_x CONTROL TEST DATA FROM OPPOSED WALL OIL-FIRED BOILERS

1	1	2	2	1	4.60000-01	2.94871+02	6.21202+02	9.22950+05	2.40000+01	1.00000+00	0.00000
2	1	2	2	1	0.00000	0.00000	9.94000+01	1.06700+02	1.40000+00	0.00000	0.00000
3	1	2	2	1	1.06700+02	0.00000	0.00000	0.00000	0.00000	4.37411+04	1.00000+00
4	1	2	2	1	4.42000+02	0.00000	0.00000	5.30000+01	0.00000	0.00000	0.00000
1	1	2	2	2	4.60000-01	2.95803+02	6.23095+02	9.22950+05	2.40000+01	1.00000+00	0.00000
2	1	2	2	2	0.00000	0.00000	9.97000+01	1.09000+02	1.80000+00	0.00000	0.00000
3	1	2	2	2	8.20000+01	0.00000	0.00000	0.00000	0.00000	4.37411+04	3.00000+00
4	1	2	2	2	3.08000+02	0.00000	0.00000	6.60000+01	0.00000	0.00000	0.00000
1	1	2	2	3	4.60000-01	2.96631+02	6.24956+02	9.22950+05	1.60000+01	1.00000+00	0.00000
2	1	2	2	3	0.00000	0.00000	1.00000+02	1.08800+02	1.80000+00	0.00000	0.00000
3	1	2	2	3	7.30000+01	0.00000	8.00000+00	0.00000	0.00000	4.37411+04	2.00000+00
4	1	2	2	3	2.92000+02	0.00000	0.00000	9.20000+01	0.00000	0.00000	0.00000
1	1	2	2	4	4.60000-01	2.97562+02	6.26849+02	9.22950+05	1.60000+01	1.00000+00	0.00000
2	1	2	2	4	0.00000	0.00000	1.00300+02	1.10900+02	2.20000+00	0.00000	0.00000
3	1	2	2	4	5.50000+01	0.00000	8.00000+00	0.00000	0.00000	4.37411+04	4.00000+00
4	1	2	2	4	2.84000+02	0.00000	0.00000	6.10000+01	0.00000	0.00000	0.00000
1	1	2	2	5	4.60000-01	1.30514+02	2.74986+02	9.22950+05	2.40000+01	1.00000+00	0.00000
2	1	2	2	5	0.00000	0.00000	4.40000+01	1.08000+02	1.70000+00	0.00000	0.00000
3	1	2	2	5	1.08000+02	0.00000	0.00000	0.00000	0.00000	4.37411+04	1.00000+00
4	1	2	2	5	2.28000+02	0.00000	0.00000	6.00000+01	0.00000	0.00000	0.00000
1	1	2	2	6	4.60000-01	1.27823+02	2.69370+02	9.22950+05	2.40000+01	1.00000+00	0.00000
2	1	2	2	6	0.00000	0.00000	4.31000+01	1.10600+02	2.10000+00	0.00000	0.00000
3	1	2	2	6	8.30000+01	0.00000	0.00000	0.00000	0.00000	4.37411+04	3.00000+00
4	1	2	2	6	1.73000+02	0.00000	0.00000	5.90000+01	0.00000	0.00000	0.00000
1	1	2	2	7	4.60000-01	1.30514+02	2.74986+02	9.22950+05	1.60000+01	1.00000+00	0.00000
2	1	2	2	7	0.00000	0.00000	4.40000+01	1.11100+02	2.20000+00	0.00000	0.00000
3	1	2	2	7	7.40000+01	0.00000	8.00000+00	0.00000	0.00000	4.37411+04	2.00000+00
4	1	2	2	7	1.52000+02	0.00000	0.00000	5.20000+01	0.00000	0.00000	0.00000
1	1	2	2	8	4.60000-01	1.31445+02	2.76847+02	9.22950+05	1.60000+01	1.00000+00	0.00000
2	1	2	2	8	0.00000	0.00000	4.43000+01	1.13400+02	2.60000+00	0.00000	0.00000
3	1	2	2	8	5.67000+01	0.00000	8.00000+00	0.00000	0.00000	4.37411+04	4.00000+00
4	1	2	2	8	1.18000+02	0.00000	0.00000	5.90000+01	0.00000	0.00000	0.00000
1	2	2	2	9	2.50000-01	2.68065+02	5.35492+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	9	0.00000	0.00000	9.45800+01	1.27600+02	4.70000+00	0.00000	0.00000
3	2	2	2	9	1.27600+02	0.00000	0.00000	0.00000	0.00000	4.50040+04	1.00000+00
4	2	2	2	9	2.46000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	2	2	2	10	2.50000-01	2.68065+02	5.35492+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	10	0.00000	0.00000	9.45800+01	1.19800+02	3.60000+00	0.00000	0.00000
3	2	2	2	10	1.19800+02	0.00000	0.00000	0.00000	0.00000	4.50040+04	1.00000+00
4	2	2	2	10	2.23000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000

TABLE C-4. (Continued)

HORIZONTALLY OPPOSED OIL FIRED BOILERS

1	2	2	2	11	2.50000-01	2.70963+02	5.41422+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	11	0.00000	0.00000	9.56300+01	1.26900+02	4.60000+00	0.00000	0.00000
3	2	2	2	11	9.50000+01	0.00000	0.00000	0.00000	0.00000	4.50040+04	3.00000+00
4	2	2	2	11	2.00000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	2	2	2	12	2.50000-01	2.14866+02	4.29308+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	12	0.00000	0.00000	7.58300+01	1.32000+02	5.30000+00	0.00000	0.00000
3	2	2	2	12	1.32000+02	0.00000	0.00000	0.00000	0.00000	4.50040+04	1.00000+00
4	2	2	2	12	2.19000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	2	2	2	13	2.50000-01	2.17246+02	4.34072+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	13	0.00000	0.00000	7.66700+01	1.20000+02	3.60000+00	0.00000	0.00000
3	2	2	2	13	1.20000+02	0.00000	0.00000	0.00000	0.00000	4.50040+04	1.00000+00
4	2	2	2	13	1.83000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	2	2	2	14	2.50000-01	2.11347+02	4.22242+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	14	0.00000	0.00000	7.45800+01	1.26900+02	4.60000+00	0.00000	0.00000
3	2	2	2	14	9.50000+01	0.00000	0.00000	0.00000	0.00000	4.50040+04	3.00000+00
4	2	2	2	14	1.64000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	2	2	2	15	2.50000-01	2.17246+02	4.34072+02	1.29887+06	1.60000+01	1.00000+00	1.00000+00
2	2	2	2	15	0.00000	0.00000	7.66700+01	1.22500+02	4.00000+00	0.00000	0.00000
3	2	2	2	15	9.20000+01	0.00000	0.00000	0.00000	0.00000	4.50040+04	3.00000+00
4	2	2	2	15	1.63000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	3	2	2	16	4.20000-01	2.61441+02	5.21832+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	3	2	2	16	0.00000	0.00000	1.00000+02	1.21300+02	3.90000+00	0.00000	0.00000
3	3	2	2	16	1.21300+02	0.00000	0.00000	0.00000	0.00000	4.42467+04	1.00000+00
4	3	2	2	16	2.91000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	3	2	2	17	4.20000-01	2.60199+02	5.19498+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	3	2	2	17	0.00000	0.00000	9.95500+01	1.13300+02	2.60000+00	0.00000	0.00000
3	3	2	2	17	1.13300+02	0.00000	0.00000	0.00000	0.00000	4.42467+04	1.00000+00
4	3	2	2	17	2.35000+02	0.00000	0.00000	1.90000+01	1.29000+03	0.00000	0.00000
1	3	2	2	18	4.20000-01	1.46142+02	2.91768+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	3	2	2	18	0.00000	0.00000	5.59100+01	1.43000+02	6.60000+00	0.00000	0.00000
3	3	2	2	18	1.43000+02	0.00000	0.00000	0.00000	0.00000	4.41908+04	1.00000+00
4	3	2	2	18	3.19000+02	0.00000	0.00000	2.20000+01	0.00000	0.00000	0.00000
1	3	2	2	19	4.20000-01	1.44900+02	2.89371+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	3	2	2	19	0.00000	0.00000	5.54500+01	1.32000+02	5.30000+00	0.00000	0.00000
3	3	2	2	19	1.32000+02	0.00000	0.00000	0.00000	0.00000	4.41908+04	1.00000+00
4	3	2	2	19	2.93000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	3	2	2	20	4.20000-01	1.82988+02	3.65270+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	3	2	2	20	0.00000	0.00000	7.00000+01	1.35000+02	5.70000+00	0.00000	0.00000
3	3	2	2	20	1.35000+02	0.00000	0.00000	0.00000	0.00000	4.41908+04	1.00000+00
4	3	2	2	20	3.08000+02	0.00000	0.00000	1.20000+01	0.00000	0.00000	0.00000

TABLE C-4. (Continued)

HORIZONTALLY OPPOSED OIL FIRED BOILERS

1	3	2	2	21	4.20000-01	1.90129+02	3.79529+02	6.34931+05	1.80000+01	1.00000+00	1.00000+00
2	3	2	2	21	0.00000	0.00000	7.27300+01	1.35200+02	5.70000+00	0.00000	0.00000
3	3	2	2	21	1.01000+02	0.00000	6.00000+00	0.00000	0.00000	4.41908+04	2.00000+00
4	3	2	2	21	1.72000+02	0.00000	0.00000	1.60000+01	0.00000	0.00000	0.00000
1	4	2	2	22	2.60000-01	2.52437+02	1.92304+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	4	2	2	22	2.43840+00	2.13360+00	9.41700+01	1.21000+02	3.75000+00	0.00000	0.00000
3	4	2	2	22	1.21000+02	5.00000+00	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	4	2	2	22	2.97400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	2	23	2.60000-01	2.52437+02	1.92304+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	4	2	2	23	2.43840+00	2.13360+00	9.41700+01	1.21500+02	3.90000+00	0.00000	0.00000
3	4	2	2	23	9.10000+01	5.00000+00	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	4	2	2	23	2.55800+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	2	24	2.60000-01	1.89819+02	1.44638+02	5.69006+05	1.00000+01	1.00000+00	0.00000
2	4	2	2	24	2.43840+00	2.13360+00	7.08300+01	1.23000+02	4.10000+00	0.00000	0.00000
3	4	2	2	24	1.23000+02	1.40000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	4	2	2	24	2.49200+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	2	25	2.60000-01	1.89819+02	1.44638+02	5.69006+05	1.00000+01	1.00000+00	0.00000
2	4	2	2	25	2.43840+00	2.13360+00	7.08300+01	1.21900+02	3.95000+00	0.00000	0.00000
3	4	2	2	25	8.70000+01	1.40000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	4	2	2	25	2.17500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	2	26	2.60000-01	1.58666+02	1.20821+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	4	2	2	26	2.43840+00	2.13360+00	5.91700+01	1.29000+02	4.95000+00	0.00000	0.00000
3	4	2	2	26	1.29000+02	1.70000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	4	2	2	26	2.62400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	2	27	2.60000-01	1.58666+02	1.20821+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	4	2	2	27	2.43840+00	2.13360+00	5.91700+01	1.29100+02	4.95000+00	0.00000	0.00000
3	4	2	2	27	8.60000+01	1.70000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	4	2	2	27	2.22100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	28	2.60000-01	2.62476+02	1.99970+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	5	2	2	28	2.43840+00	2.13360+00	9.79200+01	1.22000+02	3.95000+00	0.00000	0.00000
3	5	2	2	28	1.22000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	5	2	2	28	3.04000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	29	2.60000-01	2.62476+02	1.99970+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	5	2	2	29	2.43840+00	2.13360+00	9.79200+01	1.25400+02	4.45000+00	0.00000	0.00000
3	5	2	2	29	9.45000+01	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	5	2	2	29	2.49100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	30	2.60000-01	2.14452+02	1.63376+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	5	2	2	30	2.43840+00	2.13360+00	8.00000+01	1.26000+02	4.45000+00	0.00000	0.00000
3	5	2	2	30	1.26000+02	1.10000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	5	2	2	30	2.63200+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED OIL FIRED BOILERS

1	5	2	2	31	2.60000-01	2.14452+02	1.63376+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	5	2	2	31	2.43840+00	2.13360+00	8.00000+01	1.28400+02	4.85000+00	0.00000	0.00000
3	5	2	2	31	9.70000+01	1.10000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	5	2	2	31	2.47400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	32	2.60000-01	1.59700+02	1.21673+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	5	2	2	32	2.43840+00	2.13360+00	5.95800+01	1.26000+02	4.55000+00	0.00000	0.00000
3	5	2	2	32	1.26000+02	2.50000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	5	2	2	32	2.33100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	33	2.60000-01	1.58666+02	1.20821+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	5	2	2	33	2.43840+00	2.13360+00	5.91700+01	1.28000+02	4.80000+00	0.00000	0.00000
3	5	2	2	33	8.50000+01	2.50000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	5	2	2	33	2.01100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	34	2.60000-01	1.00498+02	7.65935+01	5.69006+05	6.00000+00	1.00000+00	0.00000
2	5	2	2	34	2.43840+00	2.13360+00	3.75000+01	1.35000+02	5.63000+00	0.00000	0.00000
3	5	2	2	34	1.35000+02	5.60000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	5	2	2	34	2.16700+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	2	35	2.60000-01	1.00498+02	7.65935+01	5.69006+05	6.00000+00	1.00000+00	0.00000
2	5	2	2	35	2.43840+00	2.13360+00	3.75000+01	1.38000+02	6.10000+00	0.00000	0.00000
3	5	2	2	35	8.30000+01	5.60000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	5	2	2	35	2.05400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	2	36	2.60000-01	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	36	1.11862+00	2.87426+00	1.00000+02	1.16000+02	3.10000+00	0.00000	0.00000
3	6	2	2	36	1.16000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	6	2	2	36	4.21300+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	2	37	2.60000-01	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	37	1.11862+00	2.87426+00	1.00000+02	1.08000+02	1.60000+00	0.00000	0.00000
3	6	2	2	37	1.08000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	6	2	2	37	2.96900+02	0.00000	0.00000	1.85600+01	0.00000	0.00000	0.00000
1	6	2	2	38	2.60000-01	2.55645+02	4.16753+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	6	2	2	38	1.11862+00	2.87426+00	1.00000+02	1.15700+02	3.00000+00	0.00000	0.00000
3	6	2	2	38	7.10000+01	0.00000	8.00000+00	0.00000	0.00000	4.56517+04	4.00000+00
4	6	2	2	38	2.39000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	2	39	2.60000-01	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	39	1.11862+00	2.87426+00	1.00000+02	1.14100+02	2.70000+00	0.00000	0.00000
3	6	2	2	39	1.05000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	6	2	2	39	3.54100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	2	40	2.60000-01	2.54196+02	4.14387+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	40	1.11862+00	2.87426+00	9.94300+01	1.12200+02	2.40000+00	0.00000	0.00000
3	6	2	2	40	1.04000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	6	2	2	40	2.61300+02	0.00000	0.00000	2.42000+01	0.00000	0.00000	0.00000

TABLE C-4. (Continued)

HORIZONTALLY OPPOSED OIL FIRED BOILERS

1	6	2	2	41	2.60000-01	1.12504+02	1.83376+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	6	2	2	41	1.05766+00	2.87426+00	4.40000+01	1.11000+02	2.20000+00	0.00000	0.00000
3	6	2	2	41	7.40000+01	3.60000+01	8.00000+00	0.00000	0.00000	4.56517+04	6.00000+00
4	6	2	2	41	1.26400+02	0.00000	0.00000	6.70000+01	0.00000	0.00000	0.00000
1	6	2	2	42	2.60000-01	1.11780+02	1.82178+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	42	1.11862+00	2.87426+00	4.37100+01	1.12700+02	2.50000+00	0.00000	0.00000
3	6	2	2	42	1.04000+02	3.60000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	6	2	2	42	1.86800+02	0.00000	0.00000	5.84000+01	0.00000	0.00000	0.00000
1	6	2	2	43	2.60000-01	1.09606+02	1.78613+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	2	43	1.11862+00	2.87426+00	4.28600+01	1.17500+02	3.30000+00	0.00000	0.00000
3	6	2	2	43	1.09000+02	3.40000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	6	2	2	43	2.47100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	2	44	2.60000-01	1.12504+02	1.83376+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	6	2	2	44	1.11862+00	2.87426+00	4.40000+01	1.22900+02	4.10000+00	0.00000	0.00000
3	6	2	2	44	7.60000+01	3.20000+01	8.00000+00	0.00000	0.00000	4.56517+04	8.00000+00
4	6	2	2	44	1.34200+02	0.00000	0.00000	5.33000+01	0.00000	0.00000	0.00000
1	6	2	2	45	2.60000-01	1.44590+02	2.35743+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	6	2	2	45	1.11862+00	2.87426+00	5.65700+01	1.18200+02	2.90000+00	0.00000	0.00000
3	6	2	2	45	7.10000+01	2.70000+01	8.00000+00	0.00000	0.00000	4.56517+04	8.00000+00
4	6	2	2	45	1.79000+02	0.00000	0.00000	3.48000+01	0.00000	0.00000	0.00000
1	7	2	2	46	2.60000-01	2.54196+02	4.14387+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	46	1.11862+00	2.87426+00	9.94300+01	1.16000+02	2.98000+00	0.00000	0.00000
3	7	2	2	46	1.16000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	7	2	2	46	4.70500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	2	47	2.60000-01	2.52022+02	4.10791+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	47	1.11862+00	2.87426+00	9.85700+01	1.14000+02	2.75000+00	0.00000	0.00000
3	7	2	2	47	1.14000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	7	2	2	47	3.76800+02	0.00000	0.00000	1.78000+01	0.00000	0.00000	0.00000
1	7	2	2	48	2.60000-01	2.54196+02	4.14387+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	48	1.11862+00	2.87426+00	9.94300+01	1.10000+02	2.03000+00	0.00000	0.00000
3	7	2	2	48	1.10000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	7	2	2	48	4.37400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	2	49	2.60000-01	2.54196+02	4.14387+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	49	1.11862+00	2.87426+00	9.94300+01	1.16000+02	3.05000+00	0.00000	0.00000
3	7	2	2	49	1.06000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	7	2	2	49	4.03100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	2	50	2.60000-01	2.54196+02	4.14387+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	50	1.11862+00	2.87426+00	9.94300+01	1.11300+02	2.25000+00	0.00000	0.00000
3	7	2	2	50	1.02000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	7	2	2	50	3.39800+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED OIL FIRED BOILERS

1	7	2	2	51	2.60000-01	2.55645+02	4.16753+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	7	2	2	51	1.11862+00	2.87426+00	1.00000+02	1.19300+02	3.55000+00	0.00000	0.00000
3	7	2	2	51	7.30000+01	0.00000	8.00000+00	0.00000	0.00000	4.56517+04	4.00000+00
4	7	2	2	51	2.21800+02	0.00000	0.00000	1.03000+01	0.00000	0.00000	0.00000
1	7	2	2	52	2.60000-01	1.09606+02	1.78613+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	52	1.11862+00	2.87426+00	4.28600+01	1.18000+02	3.40000+00	0.00000	0.00000
3	7	2	2	52	1.18000+02	3.60000+01	0.00000	0.00000	0.00000	4.56517+04	5.00000+00
4	7	2	2	52	3.31400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	2	53	2.60000-01	1.09606+02	1.78613+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	53	1.11862+00	2.87426+00	4.28600+01	1.19100+02	3.53000+00	0.00000	0.00000
3	7	2	2	53	1.10000+02	4.00000+01	0.00000	0.00000	0.00000	4.56517+04	7.00000+00
4	7	2	2	53	2.63800+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	2	54	2.60000-01	1.09606+02	1.78613+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	7	2	2	54	1.11862+00	2.87426+00	4.28600+01	1.14500+02	2.80000+00	0.00000	0.00000
3	7	2	2	54	7.00000+01	4.70000+01	8.00000+00	0.00000	0.00000	4.56517+04	8.00000+00
4	7	2	2	54	1.48400+02	0.00000	0.00000	1.98000+01	0.00000	0.00000	0.00000
1	7	2	2	55	2.60000-01	1.60735+02	2.61957+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	55	1.11862+00	2.87426+00	6.28600+01	1.15000+02	3.00000+00	0.00000	0.00000
3	7	2	2	55	1.15000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	1.00000+00
4	7	2	2	55	2.60000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	7	2	2	56	2.60000-01	1.60735+02	2.61957+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	7	2	2	56	1.11862+00	2.87426+00	6.28600+01	1.16000+02	3.05000+00	0.00000	0.00000
3	7	2	2	56	1.06000+02	0.00000	0.00000	0.00000	0.00000	4.56517+04	3.00000+00
4	7	2	2	56	2.26600+02	0.00000	0.00000	1.91000+01	0.00000	0.00000	0.00000

TABLE C-5. NO_x CONTROL TEST DATA FROM SINGLE WALL OIL-FIRED BOILERS

1	1	3	2	1	3.60000-01	2.59992+02	2.52493+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	2	1	0.00000	0.00000	1.01700+02	1.21600+02	3.90000+00	0.00000	0.00000
3	1	3	2	1	1.21600+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	1	3.67000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	1	3	2	2	3.60000-01	2.64132+02	2.56468+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	2	2	0.00000	0.00000	1.03300+02	1.08300+02	1.70000+00	0.00000	0.00000
3	1	3	2	2	1.08300+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	2	2.38000+02	0.00000	0.00000	4.20000+01	0.00000	0.00000	0.00000
1	1	3	2	3	3.60000-01	2.59992+02	2.52493+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	3	0.00000	0.00000	1.01700+02	1.20400+02	3.70000+00	0.00000	0.00000
3	1	3	2	3	9.03000+01	0.00000	4.00000+00	0.00000	0.00000	4.42444+04	2.00000+00
4	1	3	2	3	2.01000+02	0.00000	0.00000	3.20000+01	0.00000	0.00000	0.00000
1	1	3	2	4	2.10000-01	2.57715+02	2.50254+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	2	4	0.00000	0.00000	1.00800+02	1.16400+02	3.10000+00	0.00000	0.00000
3	1	3	2	4	1.16400+02	0.00000	0.00000	0.00000	0.00000	4.59592+04	1.00000+00
4	1	3	2	4	2.52000+02	0.00000	0.00000	2.40000+01	0.00000	0.00000	0.00000
1	1	3	2	5	2.10000-01	2.58957+02	2.51484+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	5	0.00000	0.00000	1.01300+02	1.21600+02	3.90000+00	0.00000	0.00000
3	1	3	2	5	9.12000+01	0.00000	4.00000+00	0.00000	0.00000	4.59592+04	2.00000+00
4	1	3	2	5	1.60000+02	0.00000	0.00000	4.30000+01	0.00000	0.00000	0.00000
1	1	3	2	6	3.60000-01	2.57715+02	2.50254+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	6	0.00000	0.00000	1.00800+02	1.29300+02	4.90000+00	0.00000	0.00000
3	1	3	2	6	9.70000+01	0.00000	4.00000+00	0.00000	0.00000	4.42444+04	2.00000+00
4	1	3	2	6	2.53000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	1	3	2	7	3.60000-01	1.59804+02	1.55174+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	2	7	0.00000	0.00000	6.25000+01	1.27000+02	4.60000+00	0.00000	0.00000
3	1	3	2	7	1.27000+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	7	3.22000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	1	3	2	8	3.60000-01	1.59804+02	1.55174+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	8	0.00000	0.00000	6.25000+01	1.19000+02	3.50000+00	0.00000	0.00000
3	1	3	2	8	8.93000+01	0.00000	4.00000+00	0.00000	0.00000	4.42444+04	2.00000+00
4	1	3	2	8	1.85000+02	0.00000	0.00000	2.90000+01	0.00000	0.00000	0.00000
1	1	3	2	9	3.60000-01	1.61357+02	1.56846+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	2	9	0.00000	0.00000	6.31700+01	1.08000+02	1.70000+00	0.00000	0.00000
3	1	3	2	9	1.08000+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	9	2.41000+02	0.00000	0.00000	2.50000+01	0.00000	0.00000	0.00000
1	1	3	2	10	2.10000-01	1.55560+02	1.51010+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	1	3	2	10	0.00000	0.00000	6.08300+01	1.33300+02	5.40000+00	0.00000	0.00000
3	1	3	2	10	1.00000+02	0.00000	4.00000+00	0.00000	0.00000	4.59592+04	2.00000+00
4	1	3	2	10	2.32000+02	0.00000	0.00000	2.60000+01	0.00000	0.00000	0.00000

TABLE C-5. (CONTINUED)

FRONT WALL OIL FIRED BOILERS

1	1	3	2	11	3.60000-01	9.80145+01	9.51740+01	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	11	0.00000	0.00000	3.83300+01	1.27000+02	4.60000+00	0.00000	0.00000
3	1	3	2	11	1.27000+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	11	2.66000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	1	3	2	12	3.60000-01	1.00084+02	9.72560+01	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	2	12	0.00000	0.00000	3.91700+01	1.10000+02	2.00000+00	0.00000	0.00000
3	1	3	2	12	1.10000+02	0.00000	0.00000	0.00000	0.00000	4.42444+04	1.00000+00
4	1	3	2	12	1.91000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	2	3	2	13	3.10000-01	2.75413+02	3.15901+02	2.69560+05	1.20000+01	1.00000+00	0.00000
2	2	3	2	13	0.00000	0.00000	9.19800+01	1.21700+02	3.90000+00	0.00000	0.00000
3	2	3	2	13	1.21700+02	0.00000	0.00000	0.00000	0.00000	4.41442+04	1.00000+00
4	2	3	2	13	5.60000+02	0.00000	0.00000	5.90000+01	0.00000	0.00000	0.00000
1	2	3	2	14	3.10000-01	2.75413+02	3.15901+02	2.69560+05	1.20000+01	1.00000+00	0.00000
2	2	3	2	14	0.00000	0.00000	9.19800+01	1.12200+02	2.40000+00	0.00000	0.00000
3	2	3	2	14	1.12200+02	0.00000	0.00000	0.00000	0.00000	4.41442+04	1.00000+00
4	2	3	2	14	4.53000+02	0.00000	0.00000	5.25000+02	0.00000	0.00000	0.00000
1	2	3	2	15	3.10000-01	2.77276+02	3.18014+02	2.69560+05	1.00000+01	1.00000+00	0.00000
2	2	3	2	15	0.00000	0.00000	9.25900+01	1.29600+02	5.00000+00	0.00000	0.00000
3	2	3	2	15	1.08000+02	0.00000	2.00000+00	0.00000	0.00000	4.41442+04	1.00000+00
4	2	3	2	15	3.73000+02	0.00000	0.00000	6.30000+01	0.00000	0.00000	0.00000
1	2	3	2	16	3.10000-01	2.77276+02	3.18014+02	2.69560+05	1.00000+01	1.00000+00	0.00000
2	2	3	2	16	0.00000	0.00000	9.25900+01	1.17600+02	3.30000+00	0.00000	0.00000
3	2	3	2	16	9.80000+01	0.00000	2.00000+00	0.00000	0.00000	4.41442+04	2.00000+00
4	2	3	2	16	2.93000+02	0.00000	0.00000	9.50000+01	0.00000	0.00000	0.00000
1	2	3	2	17	3.10000-01	1.66324+02	1.90821+02	2.69560+05	1.20000+01	1.00000+00	0.00000
2	2	3	2	17	0.00000	0.00000	5.55600+01	1.26000+02	4.50000+00	0.00000	0.00000
3	2	3	2	17	1.26000+02	0.00000	0.00000	0.00000	0.00000	4.41442+04	1.00000+00
4	2	3	2	17	3.61000+02	0.00000	0.00000	4.60000+01	0.00000	0.00000	0.00000
1	2	3	2	18	3.10000-01	1.62702+02	1.86562+02	2.69560+05	1.00000+01	1.00000+00	0.00000
2	2	3	2	18	0.00000	0.00000	5.43200+01	1.21200+02	3.90000+00	0.00000	0.00000
3	2	3	2	18	1.01000+02	0.00000	2.00000+00	0.00000	0.00000	4.41442+04	2.00000+00
4	2	3	2	18	2.52000+02	0.00000	0.00000	9.40000+01	0.00000	0.00000	0.00000
1	2	3	2	19	4.10000-01	6.65505+01	7.63095+01	2.69560+05	1.00000+01	1.00000+00	0.00000
2	2	3	2	19	0.00000	0.00000	2.22200+01	1.36000+02	5.80000+00	0.00000	0.00000
3	2	3	2	19	1.36000+02	0.00000	0.00000	0.00000	0.00000	4.37924+04	1.00000+00
4	2	3	2	19	2.58000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	2	3	2	20	4.10000-01	6.28245+01	7.20824+01	2.69560+05	1.00000+01	1.00000+00	0.00000
2	2	3	2	20	0.00000	0.00000	2.09900+01	1.27200+02	5.30000+00	0.00000	0.00000
3	2	3	2	20	1.06000+02	0.00000	2.00000+00	0.00000	0.00000	4.37924+04	2.00000+00
4	2	3	2	20	2.03000+02	0.00000	0.00000	8.70000+01	0.00000	0.00000	0.00000

TABLE C-5. (Continued)

FRONT WALL OIL FIRED BOILERS

1	3	3	2	21	3.10000-01	2.84107+02	7.73537+02	7.45978+05	2.40000+01	2.00000+00	0.00000
2	3	3	2	21	0.00000	0.00000	9.92000+01	1.15100+02	2.90000+00	0.00000	0.00000
3	3	3	2	21	1.15100+02	0.00000	0.00000	0.00000	0.00000	4.38506+04	1.00000+00
4	3	3	2	21	3.50000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	3	3	2	22	3.10000-01	2.90938+02	7.92244+02	7.45978+05	2.40000+01	2.00000+00	0.00000
2	3	3	2	22	0.00000	0.00000	1.01600+02	1.09800+02	2.00000+00	0.00000	0.00000
3	3	3	2	22	1.09800+02	0.00000	0.00000	0.00000	0.00000	4.38506+04	1.00000+00
4	3	3	2	22	3.70000+02	0.00000	0.00000	4.10000+01	0.00000	0.00000	0.00000
1	3	3	2	23	3.10000-01	2.79553+02	7.61045+02	7.45978+05	2.08000+01	2.00000+00	0.00000
2	3	3	2	23	0.00000	0.00000	9.76000+01	1.10000+02	2.00000+00	0.00000	0.00000
3	3	3	2	23	9.53000+01	0.00000	3.20000+00	0.00000	0.00000	4.38506+04	2.10000+00
4	3	3	2	23	2.70000+02	0.00000	0.00000	2.70000+02	0.00000	0.00000	0.00000
1	3	3	2	24	3.10000-01	2.70342+02	7.36092+02	7.45978+05	2.08000+01	2.00000+00	0.00000
2	3	3	2	24	0.00000	0.00000	9.44000+01	1.06700+02	1.40000+00	0.00000	0.00000
3	3	3	2	24	9.25000+01	2.50000+01	3.20000+00	0.00000	0.00000	4.38506+04	6.10000+00
4	3	3	2	24	1.42000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	2	25	3.10000-01	1.92406+02	5.24009+02	7.45978+05	2.40000+01	2.00000+00	0.00000
2	3	3	2	25	0.00000	0.00000	6.72000+01	1.13000+02	2.60000+00	0.00000	0.00000
3	3	3	2	25	1.13000+02	0.00000	0.00000	0.00000	0.00000	4.38506+04	1.00000+00
4	3	3	2	25	3.53000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	2	26	3.10000-01	1.97064+02	5.36470+01	7.45978+05	2.40000+01	2.00000+00	0.00000
2	3	3	2	26	0.00000	0.00000	6.88000+01	1.05000+02	1.00000+00	0.00000	0.00000
3	3	3	2	26	1.05000+02	0.00000	0.00000	0.00000	0.00000	4.38506+04	1.00000+00
4	3	3	2	26	2.98000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	2	27	3.10000-01	1.97064+02	5.36470+02	7.45978+05	2.08000+01	2.00000+00	0.00000
2	3	3	2	27	0.00000	0.00000	6.88000+01	1.11500+02	2.30000+00	0.00000	0.00000
3	3	3	2	27	9.67000+01	0.00000	3.20000+00	0.00000	0.00000	4.38506+04	2.10000+00
4	3	3	2	27	2.67000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	2	28	3.10000-01	1.97064+02	5.36470+02	7.45978+05	2.08000+01	2.00000+00	0.00000
2	3	3	2	28	0.00000	0.00000	6.88000+01	1.04200+02	9.00000-01	0.00000	0.00000
3	3	3	2	28	9.03000+01	0.00000	3.20000+00	0.00000	0.00000	4.38506+04	2.10000+00
4	3	3	2	28	2.29000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	2	29	3.20000-01	1.93338+02	5.26343+02	7.45978+05	2.40000+01	2.00000+00	0.00000
2	3	3	2	29	0.00000	0.00000	6.75000+01	1.07000+02	1.20000+00	0.00000	0.00000
3	3	3	2	29	1.07000+02	2.50000+01	0.00000	0.00000	0.00000	4.38506+04	5.00000+00
4	3	3	2	29	1.74000+02	0.00000	0.00000	5.30000+01	0.00000	0.00000	0.00000
1	3	3	2	30	3.20000-01	1.92406+02	5.24009+02	7.45978+05	2.08000+01	2.00000+00	0.00000
2	3	3	2	30	0.00000	0.00000	6.72000+01	1.05000+02	1.00000+00	0.00000	0.00000
3	3	3	2	30	9.10000+01	2.50000+01	3.20000+00	0.00000	0.00000	4.38506+04	6.10000+00
4	3	3	2	30	1.53000+02	0.00000	0.00000	1.00000+03	0.00000	0.00000	0.00000

TABLE C-5. (Continued)

FRONT WALL OIL FIRED BOILERS

1	4	3	2	31	2.40000-01	1.91164+02	2.56689+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	4	3	2	31	2.43840+00	0.00000	9.67000+01	1.09000+02	1.88000+00	0.00000	0.00000
3	4	3	2	31	1.09000+02	2.70000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	4	3	2	31	3.57000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	4	3	2	32	2.40000-01	1.58148+02	2.12336+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	4	3	2	32	2.43840+00	0.00000	8.00000+01	1.08000+02	1.70000+00	0.00000	0.00000
3	4	3	2	32	1.08000+02	3.00000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	4	3	2	32	3.10600+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	4	3	2	33	2.40000-01	1.16231+02	1.56089+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	4	3	2	33	2.43840+00	0.00000	5.88000+01	1.08000+02	1.75000+00	0.00000	0.00000
3	4	3	2	33	1.08000+02	4.70000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	4	3	2	33	2.70000+02	0.00000	0.00000	2.15000+01	0.00000	0.00000	0.00000
1	4	3	2	34	2.40000-01	7.84530+01	1.05363+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	4	3	2	34	2.43840+00	0.00000	3.97000+01	1.18000+02	3.35000+00	0.00000	0.00000
3	4	3	2	34	1.18000+02	7.30000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	4	3	2	34	2.80500+02	0.00000	0.00000	1.10000+01	0.00000	0.00000	0.00000
1	4	3	2	35	2.40000-01	1.83299+02	2.46058+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	4	3	2	35	2.43840+00	0.00000	9.27000+01	1.29400+02	4.98000+00	0.00000	0.00000
3	4	3	2	35	8.62000+01	3.00000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	4	3	2	35	2.63000+02	0.00000	0.00000	4.50000+01	0.00000	0.00000	0.00000
1	4	3	2	36	2.40000-01	1.90026+02	2.55080+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	4	3	2	36	2.43840+00	0.00000	9.61000+01	1.15000+02	3.00000+00	0.00000	0.00000
3	4	3	2	36	7.70000+01	1.20000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	4	3	2	36	2.11000+02	0.00000	0.00000	2.50000+01	0.00000	0.00000	0.00000
1	4	3	2	37	2.40000-01	1.53387+02	2.05963+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	4	3	2	37	2.43840+00	0.00000	7.76000+01	1.15000+02	2.95000+00	0.00000	0.00000
3	4	3	2	37	1.15000+02	3.10000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	4	3	2	37	1.77000+02	0.00000	0.00000	1.80000+01	0.00000	0.00000	0.00000
1	4	3	2	38	2.40000-01	8.14545+01	1.09370+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	4	3	2	38	2.43840+00	0.00000	4.12000+01	1.18500+02	3.38000+00	0.00000	0.00000
3	4	3	2	38	7.90000+01	6.30000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	4	3	2	38	1.51200+02	0.00000	0.00000	2.25000+01	0.00000	0.00000	0.00000
1	5	3	2	39	2.40000-01	1.91164+02	2.56689+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	5	3	2	39	2.43840+00	0.00000	9.67000+01	1.08000+02	1.70000+00	0.00000	0.00000
3	5	3	2	39	1.08000+02	2.00000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	5	3	2	39	3.10600+02	0.00000	0.00000	2.75000+01	0.00000	0.00000	0.00000
1	5	3	2	40	2.40000-01	1.91164+02	2.56689+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	5	3	2	40	2.43840+00	0.00000	9.67000+01	1.10000+02	1.98000+00	0.00000	0.00000
3	5	3	2	40	1.10000+02	2.10000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	5	3	2	40	2.97000+02	0.00000	0.00000	2.84000+01	0.00000	0.00000	0.00000

TABLE C-5. (Continued)

FRONT WALL OIL FIRED BOILERS

1	5	3	2	41	2.40000-01	1.92924+02	2.59055+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	5	3	2	41	2.43840+00	0.00000	9.76000+01	1.14000+02	2.78000+00	0.00000	0.00000
3	5	3	2	41	7.60000+01	1.90000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	5	3	2	41	1.84000+02	0.00000	0.00000	2.96000+01	0.00000	0.00000	0.00000
1	5	3	2	42	2.40000-01	1.53387+02	2.05963+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	5	3	2	42	2.43840+00	0.00000	7.76000+01	1.09000+02	1.80000+00	0.00000	0.00000
3	5	3	2	42	1.09000+02	3.60000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	5	3	2	42	2.54000+02	0.00000	0.00000	2.80000+01	0.00000	0.00000	0.00000
1	5	3	2	43	2.40000-01	1.58148+02	2.12336+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	5	3	2	43	2.43840+00	0.00000	8.00000+01	1.15500+02	3.10000+00	0.00000	0.00000
3	5	3	2	43	7.70000+01	3.50000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	5	3	2	43	1.66000+02	0.00000	0.00000	3.50000+01	0.00000	0.00000	0.00000
1	5	3	2	44	2.40000-01	1.19750+02	1.60853+02	5.17731+05	1.20000+01	1.00000+00	0.00000
2	5	3	2	44	2.43840+00	0.00000	6.06000+01	1.11000+02	2.18000+00	0.00000	0.00000
3	5	3	2	44	1.11000+02	5.20000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	5	3	2	44	2.50600+02	0.00000	0.00000	2.87000+01	0.00000	0.00000	0.00000
1	5	3	2	45	2.40000-01	1.13229+02	1.52083+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	5	3	2	45	2.43840+00	0.00000	5.73000+01	1.17000+02	3.10000+00	0.00000	0.00000
3	5	3	2	45	7.80000+01	5.20000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	5	3	2	45	1.61000+02	0.00000	0.00000	4.00000+01	0.00000	0.00000	0.00000
1	5	3	2	46	2.40000-01	7.29675+01	9.79500+01	5.17731+05	1.20000+01	1.00000+00	0.00000
2	5	3	2	46	2.43840+00	0.00000	3.69000+01	1.18000+02	3.38000+00	0.00000	0.00000
3	5	3	2	46	1.18000+02	8.70000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	5	3	2	46	2.56400+02	0.00000	0.00000	3.10000+01	0.00000	0.00000	0.00000
1	5	3	2	47	2.40000-01	7.84530+01	1.06941+02	5.17731+05	8.00000+00	1.00000+00	0.00000
2	5	3	2	47	2.43840+00	0.00000	3.97000+01	1.23000+02	4.05000+00	0.00000	0.00000
3	5	3	2	47	8.20000+01	8.50000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	5	3	2	47	1.83000+02	0.00000	0.00000	3.72000+01	0.00000	0.00000	0.00000
1	6	3	2	48	2.40000-01	2.51298+02	2.43976+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	6	3	2	48	1.98120+00	0.00000	9.83000+01	1.28000+02	4.75000+00	0.00000	0.00000
3	6	3	2	48	9.60000+01	3.00000+00	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	6	3	2	48	2.02700+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	2	49	2.40000-01	2.53575+02	2.46216+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	6	3	2	49	1.98120+00	0.00000	9.92000+01	1.12000+02	2.29000+00	0.00000	0.00000
3	6	3	2	49	8.40000+01	4.00000+00	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	6	3	2	49	1.67400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	2	50	2.40000-01	2.16315+02	2.09970+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	6	3	2	50	1.98120+00	0.00000	8.46000+01	1.16000+02	2.98000+00	0.00000	0.00000
3	6	3	2	50	8.70000+01	1.70000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	6	3	2	50	1.30000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-5. (Continued)

FRONT WALL OIL FIRED BOILERS

1	6	3	2	51	2.40000-01	1.24510+02	1.20884+02	4.70265+05	8.00000+00	1.00000+00	0.00000
2	6	3	2	51	1.98120+00	0.00000	4.87000+01	1.18500+02	3.38000+00	0.00000	0.00000
3	6	3	2	51	7.90000+01	3.80000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	6	3	2	51	1.49000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	2	52	2.40000-01	2.45916+02	2.38771+02	4.70265+05	1.60000+01	1.00000+00	0.00000
2	7	3	2	52	1.98120+00	0.00000	9.62000+01	1.21600+02	3.89000+00	0.00000	0.00000
3	7	3	2	52	1.21600+02	0.00000	0.00000	0.00000	0.00000	4.56703+04	1.00000+00
4	7	3	2	52	3.59800+02	0.00000	0.00000	6.31000+01	0.00000	0.00000	0.00000
1	7	3	2	53	2.40000-01	2.42914+02	2.35774+02	4.70265+05	1.60000+01	1.00000+00	0.00000
2	7	3	2	53	1.98120+00	0.00000	9.50000+01	1.16300+02	3.09000+00	0.00000	0.00000
3	7	3	2	53	1.16300+02	0.00000	0.00000	0.00000	0.00000	4.56703+04	1.00000+00
4	7	3	2	53	2.32000+02	0.00000	0.00000	3.00000+01	0.00000	0.00000	0.00000
1	7	3	2	54	2.40000-01	2.42914+02	2.35774+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	7	3	2	54	1.98120+00	0.00000	9.50000+01	1.20000+02	3.71000+00	0.00000	0.00000
3	7	3	2	54	9.00000+01	2.00000+00	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	7	3	2	54	1.86400+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	2	55	2.40000-01	2.45916+02	2.38771+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	7	3	2	55	1.98120+00	0.00000	9.62000+01	1.21300+02	3.91000+00	0.00000	0.00000
3	7	3	2	55	9.10000+01	4.00000+00	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	7	3	2	55	1.45300+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	2	56	2.40000-01	1.71499+02	1.66531+02	4.70265+05	1.60000+01	1.00000+00	0.00000
2	7	3	2	56	1.98120+00	0.00000	6.71000+01	1.27000+02	4.63000+00	0.00000	0.00000
3	7	3	2	56	1.27000+02	1.30000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	7	3	2	56	3.16700+02	0.00000	0.00000	4.40000+01	0.00000	0.00000	0.00000
1	7	3	2	57	2.40000-01	1.66221+02	1.61326+02	4.70265+05	1.60000+01	1.00000+00	0.00000
2	7	3	2	57	1.98120+00	0.00000	6.50000+01	1.08000+02	1.72000+00	0.00000	0.00000
3	7	3	2	57	1.08000+02	3.10000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	7	3	2	57	2.19400+02	0.00000	0.00000	2.80000+01	0.00000	0.00000	0.00000
1	7	3	2	58	2.40000-01	1.68187+02	1.63313+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	7	3	2	58	1.98120+00	0.00000	6.58000+01	1.17000+02	3.23000+00	0.00000	0.00000
3	7	3	2	58	8.80000+01	2.70000+01	4.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	7	3	2	58	1.34000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	2	59	2.40000-01	1.15092+02	1.11673+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	7	3	2	59	1.98120+00	0.00000	4.50000+01	1.27000+02	4.60000+00	0.00000	0.00000
3	7	3	2	59	1.27000+02	2.00000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	7	3	2	59	2.59000+02	0.00000	0.00000	3.30000+01	0.00000	0.00000	0.00000
1	7	3	2	60	2.40000-01	1.15092+02	1.11673+02	4.70265+05	1.20000+01	1.00000+00	0.00000
2	7	3	2	60	1.98120+00	0.00000	4.50000+01	1.10000+02	2.04000+00	0.00000	0.00000
3	7	3	2	60	1.10000+02	5.10000+01	0.00000	0.00000	0.00000	4.56703+04	5.00000+00
4	7	3	2	60	1.88000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-5. (Concluded)

FRONT WALL OIL FIRED BOILERS

1	7	3	2	61	2.40000-01	1.18093+02	1.14669+02	4.70265+05	8.00000+00	1.00000+00	0.00000
2	7	3	2	61	1.98120+00	0.00000	4.62000+01	1.23800+02	4.30000+00	0.00000	0.00000
3	7	3	2	61	9.90000+01	4.10000+01	2.00000+00	0.00000	0.00000	4.56703+04	6.00000+00
4	7	3	2	61	1.68000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-6. NO_x CONTROL TEST DATA FROM OPPOSED WALL GAS-FIRED BOILERS

1	1	2	1	1	0.00000	2.99425+02	6.30729+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	1	0.00000	0.00000	1.04400+02	1.12700+02	2.60000+00	0.00000	0.00000
3	1	2	1	1	1.12700+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	2	1	1	9.46000+02	0.00000	0.00000	8.60000+01	0.00000	0.00000	0.00000
1	1	2	1	2	0.00000	2.99425+02	6.30729+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	2	0.00000	0.00000	1.04400+02	1.07000+02	1.60000+00	0.00000	0.00000
3	1	2	1	2	1.07000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	2	1	2	7.83000+02	0.00000	0.00000	7.40000+01	0.00000	0.00000	0.00000
1	1	2	1	3	0.00000	2.99425+02	6.30729+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	3	0.00000	0.00000	1.04400+02	1.13800+02	2.80000+00	0.00000	0.00000
3	1	2	1	3	9.75000+01	0.00000	0.00000	0.00000	0.00000	3.92769+01	3.00000+00
4	1	2	1	3	5.15000+02	0.00000	0.00000	6.70000+01	0.00000	0.00000	0.00000
1	1	2	1	4	0.00000	2.96528+02	6.24672+02	8.92185+05	3.00000+01	1.00000+00	0.00000
2	1	2	1	4	0.00000	0.00000	1.03400+02	1.07000+02	1.50000+00	0.00000	0.00000
3	1	2	1	4	8.92000+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	2	1	4	3.55000+02	0.00000	0.00000	1.50000+02	0.00000	0.00000	0.00000
1	1	2	1	5	0.00000	2.99425+02	6.30729+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	5	0.00000	0.00000	1.04400+02	1.09000+02	1.90000+00	0.00000	0.00000
3	1	2	1	5	9.34000+01	0.00000	0.00000	0.00000	0.00000	3.92769+01	3.00000+00
4	1	2	1	5	3.81000+02	0.00000	0.00000	8.40000+01	0.00000	0.00000	0.00000
1	1	2	1	6	0.00000	2.99425+02	6.30729+02	8.92185+05	3.00000+01	1.00000+00	0.00000
2	1	2	1	6	0.00000	0.00000	1.04400+02	1.09500+02	2.00000+00	0.00000	0.00000
3	1	2	1	6	7.82000+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	4.00000+00
4	1	2	1	6	2.13000+02	0.00000	0.00000	1.43000+02	0.00000	0.00000	0.00000
1	1	2	1	7	0.00000	1.35067+02	2.84481+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	7	0.00000	0.00000	4.70900+01	1.08000+02	1.70000+00	0.00000	0.00000
3	1	2	1	7	1.08000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	2	1	7	2.99000+02	0.00000	0.00000	6.40000+01	0.00000	0.00000	0.00000
1	1	2	1	8	0.00000	1.32273+02	2.78613+02	8.92185+05	3.00000+01	1.00000+00	0.00000
2	1	2	1	8	0.00000	0.00000	4.61200+01	1.08000+02	1.70000+00	0.00000	0.00000
3	1	2	1	8	9.00000+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	2	1	8	8.70000+01	0.00000	0.00000	5.40000+01	0.00000	0.00000	0.00000
1	1	2	1	9	0.00000	1.32273+02	2.78613+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	9	0.00000	0.00000	4.61200+01	1.08000+02	1.70000+00	0.00000	0.00000
3	1	2	1	9	9.26000+01	0.00000	0.00000	0.00000	0.00000	3.92769+01	3.00000+00
4	1	2	1	9	1.65000+02	0.00000	0.00000	7.40000+01	0.00000	0.00000	0.00000
1	1	2	1	10	0.00000	1.32273+02	2.78613+02	8.92185+05	3.60000+01	1.00000+00	0.00000
2	1	2	1	10	0.00000	0.00000	4.61200+01	1.06000+02	1.30000+00	0.00000	0.00000
3	1	2	1	10	1.06000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	2	1	10	2.49000+02	0.00000	0.00000	5.70000+01	0.00000	0.00000	0.00000

TABLE C-6. (Continued)

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	1	2	1	11	0.00000	1.39208+02	2.93251+02	8.92185+05	3.00000+01	1.00000+00	0.00000
2	1	2	1	11	0.00000	0.00000	4.85400+01	1.10100+02	2.10000+00	0.00000	0.00000
3	1	2	1	11	7.86000+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	4.00000+00
4	1	2	1	11	5.60000+01	0.00000	0.00000	7.60000+01	0.00000	0.00000	0.00000
1	2	2	1	12	0.00000	2.83383+02	5.66154+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	12	0.00000	0.00000	1.00000+02	1.21000+02	4.00000+00	0.00000	0.00000
3	2	2	1	12	1.21000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	2	1	12	2.36000+02	0.00000	0.00000	1.20000+01	0.00000	0.00000	0.00000
1	2	2	1	13	0.00000	2.79036+02	5.57322+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	13	0.00000	0.00000	9.84400+01	1.15000+02	3.00000+00	0.00000	0.00000
3	2	2	1	13	1.15000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	2	1	13	1.98000+02	0.00000	0.00000	6.10000+01	0.00000	0.00000	0.00000
1	2	2	1	14	0.00000	2.79036+02	5.57322+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	14	0.00000	0.00000	9.84400+01	1.21300+02	4.00000+00	0.00000	0.00000
3	2	2	1	14	9.09500+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	2	1	14	1.45000+02	0.00000	0.00000	1.30000+01	0.00000	0.00000	0.00000
1	2	2	1	15	0.00000	2.79036+02	5.57322+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	15	0.00000	0.00000	9.84400+01	1.15000+02	3.00000+00	0.00000	0.00000
3	2	2	1	15	8.63000+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	2	1	15	1.40000+02	0.00000	0.00000	2.10000+02	0.00000	0.00000	0.00000
1	2	2	1	16	0.00000	1.42933+02	2.85585+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	16	0.00000	0.00000	5.04400+01	1.25000+02	4.50000+00	0.00000	0.00000
3	2	2	1	16	1.25000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	2	1	16	1.66000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	2	2	1	17	0.00000	1.42933+02	2.85585+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	17	0.00000	0.00000	5.04400+01	1.15000+02	3.00000+00	0.00000	0.00000
3	2	2	1	17	1.15000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	2	1	17	1.20000+02	0.00000	0.00000	4.30000+01	0.00000	0.00000	0.00000
1	2	2	1	18	0.00000	1.41691+02	2.83093+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	18	0.00000	0.00000	5.00000+01	1.24500+02	4.50000+00	0.00000	0.00000
3	2	2	1	18	9.34000+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	2	1	18	9.50000+01	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	2	2	1	19	0.00000	1.42933+02	2.85585+02	1.29887+06	2.40000+01	1.00000+00	1.00000+00
2	2	2	1	19	0.00000	0.00000	5.04400+01	1.14400+02	2.90000+00	0.00000	0.00000
3	2	2	1	19	8.58000+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	2	1	19	7.00000+01	0.00000	0.00000	5.10000+02	0.00000	0.00000	0.00000
1	3	2	1	20	0.00000	1.42830+02	2.14039+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	20	0.00000	0.00000	9.38300+01	1.14100+02	2.90000+00	0.00000	0.00000
3	3	2	1	20	1.14100+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	20	5.56000+02	0.00000	0.00000	6.00000+00	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	3	2	1	21	0.00000	1.40553+02	2.10632+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	21	0.00000	0.00000	9.23300+01	1.10000+02	2.10000+00	0.00000	0.00000
3	3	2	1	21	1.10000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	21	5.24000+02	0.00000	0.00000	8.00000+00	0.00000	0.00000	0.00000
1	3	2	1	22	0.00000	1.05259+02	1.57793+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	22	0.00000	0.00000	6.91700+01	1.18000+02	3.55000+00	0.00000	0.00000
3	3	2	1	22	1.18000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	22	3.42000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	3	2	1	23	0.00000	1.02983+02	1.54386+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	23	0.00000	0.00000	6.76700+01	1.10000+02	1.85000+00	0.00000	0.00000
3	3	2	1	23	1.10000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	23	2.93000+02	0.00000	0.00000	5.00000+00	0.00000	0.00000	0.00000
1	3	2	1	24	0.00000	8.26965+01	1.23944+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	24	0.00000	0.00000	5.43300+01	1.17000+02	3.35000+00	0.00000	0.00000
3	3	2	1	24	1.17000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	24	2.46000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	3	2	1	25	0.00000	8.26965+01	1.23944+02	1.52770+06	2.40000+01	1.00000+00	1.00000+00
2	3	2	1	25	0.00000	0.00000	5.43300+01	1.08000+02	1.75000+00	0.00000	0.00000
3	3	2	1	25	1.08000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	2	1	25	2.05000+02	0.00000	0.00000	1.00000+01	0.00000	0.00000	0.00000
1	3	2	1	26	0.00000	8.26965+01	1.23944+02	1.52770+06	1.60000+01	1.00000+00	1.00000+00
2	3	2	1	26	0.00000	0.00000	5.43300+01	1.19600+02	3.75000+00	0.00000	0.00000
3	3	2	1	26	7.97000+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	3	2	1	26	1.04000+02	0.00000	0.00000	4.00000+00	0.00000	0.00000	0.00000
1	3	2	1	27	0.00000	8.16615+01	1.22430+02	1.52770+06	1.60000+01	1.00000+00	1.00000+00
2	3	2	1	27	0.00000	0.00000	5.36700+01	1.08700+02	1.85000+00	0.00000	0.00000
3	3	2	1	27	7.25000+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	3	2	1	27	9.10000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	2	1	28	0.00000	2.61441+02	5.21832+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	4	2	1	28	0.00000	0.00000	1.00000+02	1.17000+02	3.30000+00	0.00000	0.00000
3	4	2	1	28	1.17000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	4	2	1	28	6.75000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	4	2	1	29	0.00000	2.61441+02	5.21832+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	4	2	1	29	0.00000	0.00000	1.00000+02	1.08000+02	1.70000+00	0.00000	0.00000
3	4	2	1	29	1.08000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	4	2	1	29	5.19000+02	0.00000	0.00000	3.40000+01	0.00000	0.00000	0.00000
1	4	2	1	30	0.00000	2.61441+02	5.21832+02	6.34931+05	1.80000+01	1.00000+00	1.00000+00
2	4	2	1	30	0.00000	0.00000	1.00000+02	1.20600+02	3.90000+00	0.00000	0.00000
3	4	2	1	30	9.04700+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	4	2	1	30	2.86000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000

TABLE C-6. (Continued)

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	4	2	1	31	0.00000	2.61441+02	5.21832+02	6.34931+05	1.80000+01	1.00000+00	1.00000+00
2	4	2	1	31	0.00000	0.00000	1.00000+02	1.10500+02	2.20000+00	0.00000	0.00000
3	4	2	1	31	8.28700+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	4	2	1	31	2.70000+02	0.00000	0.00000	2.50000+01	0.00000	0.00000	0.00000
1	4	2	1	32	0.00000	2.15176+02	4.29561+02	6.34931+05	1.60000+01	1.00000+00	1.00000+00
2	4	2	1	32	0.00000	0.00000	8.23200+01	1.13000+02	2.60000+00	0.00000	0.00000
3	4	2	1	32	1.13000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	4	2	1	32	4.00000+02	0.00000	0.00000	2.80000+01	0.00000	0.00000	0.00000
1	4	2	1	33	0.00000	2.12071+02	4.23220+02	6.34931+05	1.60000+01	1.00000+00	1.00000+00
2	4	2	1	33	0.00000	0.00000	8.11000+01	1.13300+02	2.70000+00	0.00000	0.00000
3	4	2	1	33	7.55400+01	0.00000	8.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	4	2	1	33	2.84000+02	0.00000	0.00000	3.50000+01	0.00000	0.00000	0.00000
1	4	2	1	34	0.00000	1.41899+02	2.83188+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	4	2	1	34	0.00000	0.00000	5.42700+01	1.27000+02	4.90000+00	0.00000	0.00000
3	4	2	1	34	1.27000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	4	2	1	34	3.13000+02	0.00000	0.00000	2.10000+01	0.00000	0.00000	0.00000
1	4	2	1	35	0.00000	1.33929+02	2.67288+02	6.34931+05	2.40000+01	1.00000+00	1.00000+00
2	4	2	1	35	0.00000	0.00000	5.12200+01	1.11000+02	2.40000+00	0.00000	0.00000
3	4	2	1	35	1.11000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	4	2	1	35	2.36000+02	0.00000	0.00000	2.40000+01	0.00000	0.00000	0.00000
1	4	2	1	36	0.00000	1.37137+02	2.73661+02	6.34931+05	1.80000+01	1.00000+00	1.00000+00
2	4	2	1	36	0.00000	0.00000	5.24400+01	1.25000+02	4.60000+00	0.00000	0.00000
3	4	2	1	36	9.37800+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	4	2	1	36	1.50000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	4	2	1	37	0.00000	1.35482+02	2.70475+02	6.34931+05	1.80000+01	1.00000+00	1.00000+00
2	4	2	1	37	0.00000	0.00000	5.18300+01	1.13600+02	2.80000+00	0.00000	0.00000
3	4	2	1	37	8.52300+01	0.00000	6.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	4	2	1	37	1.07000+02	0.00000	0.00000	8.60000+01	0.00000	0.00000	0.00000
1	5	2	1	38	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	38	1.11862+00	2.87426+00	1.00000+02	1.12000+02	2.40000+00	0.00000	0.00000
3	5	2	1	38	1.12000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	38	9.80000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	39	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	39	1.11862+00	2.87426+00	1.00000+02	1.11000+02	2.30000+00	0.00000	0.00000
3	5	2	1	39	1.11000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	39	9.19000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	1	40	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	40	1.11862+00	2.87426+00	1.00000+02	1.06000+02	1.35000+00	0.00000	0.00000
3	5	2	1	40	1.06000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	40	8.40000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000

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1	5	2	1	41	0.00000	1.11056+02	1.81010+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	41	1.11862+00	2.87426+00	4.34300+01	1.10000+02	2.10000+00	0.00000	0.00000
3	5	2	1	41	1.10000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	41	3.00000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	42	0.00000	2.55645+02	4.16753+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	42	1.11862+00	2.87426+00	1.00000+02	1.11400+02	2.35000+00	0.00000	0.00000
3	5	2	1	42	7.42500+01	0.00000	8.00000+00	0.00000	0.00000	4.00602+01	2.00000+00
4	5	2	1	42	3.81000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	43	0.00000	2.55645+02	4.16753+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	43	1.11862+00	2.87426+00	1.00000+02	1.11400+02	2.35000+00	0.00000	0.00000
3	5	2	1	43	6.85500+01	0.00000	8.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	5	2	1	43	2.05000+02	0.00000	0.00000	1.83000+02	0.00000	0.00000	0.00000
1	5	2	1	44	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	44	1.11862+00	2.87426+00	1.00000+02	1.13900+02	2.80000+00	0.00000	0.00000
3	5	2	1	44	1.05100+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	3.00000+00
4	5	2	1	44	4.77000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	45	0.00000	1.11056+02	1.81010+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	45	1.11862+00	2.87426+00	4.34300+01	1.10000+02	2.10000+00	0.00000	0.00000
3	5	2	1	45	1.10000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	45	3.00000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	46	0.00000	1.11056+02	1.81010+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	46	1.11862+00	2.87426+00	4.34300+01	1.10800+02	2.20000+00	0.00000	0.00000
3	5	2	1	46	1.02300+02	2.70000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	5	2	1	46	1.72000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	47	0.00000	1.11056+02	1.81010+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	47	1.11862+00	2.87426+00	4.34300+01	1.10000+02	2.10000+00	0.00000	0.00000
3	5	2	1	47	7.33300+01	2.70000+01	8.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	5	2	1	47	8.00000+01	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	5	2	1	48	0.00000	1.07330+02	1.75048+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	48	1.11862+00	2.87426+00	4.20000+01	1.07700+02	1.65000+00	0.00000	0.00000
3	5	2	1	48	6.62700+01	2.70000+01	8.00000+00	0.00000	0.00000	4.00602+01	8.00000+00
4	5	2	1	48	4.30000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	1	49	0.00000	1.82574+02	2.97699+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	49	1.11862+00	2.87426+00	7.14300+01	1.16200+02	3.20000+00	0.00000	0.00000
3	5	2	1	49	1.16200+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	5	2	1	49	3.57000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	1	50	0.00000	1.82574+02	2.97699+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	5	2	1	50	1.11862+00	2.87426+00	7.14300+01	1.16200+02	3.20000+00	0.00000	0.00000
3	5	2	1	50	1.07200+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	3.00000+00
4	5	2	1	50	2.15000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-6. (Continued)

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	5	2	1	51	0.00000	1.82574+02	2.97699+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	51	1.11862+00	2.87426+00	7.14300+01	1.16200+02	3.20000+00	0.00000	0.00000
3	5	2	1	51	7.15100+01	0.00000	8.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	5	2	1	51	1.15000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	5	2	1	52	0.00000	1.82574+02	2.97699+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	5	2	1	52	1.11862+00	2.87426+00	7.14300+01	1.13200+02	2.65000+00	0.00000	0.00000
3	5	2	1	52	6.96500+01	0.00000	8.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	5	2	1	52	9.60000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	2	1	53	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	53	1.11862+00	2.87426+00	1.00000+02	1.15000+02	3.00000+00	0.00000	0.00000
3	6	2	1	53	1.15000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	6	2	1	53	9.10000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	6	2	1	54	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	54	1.11862+00	2.87426+00	1.00000+02	1.13000+02	2.70000+00	0.00000	0.00000
3	6	2	1	54	1.13000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	6	2	1	54	7.95000+02	0.00000	0.00000	1.90000+01	0.00000	0.00000	0.00000
1	6	2	1	55	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	55	1.11862+00	2.87426+00	1.00000+02	1.12000+02	2.50000+00	0.00000	0.00000
3	6	2	1	55	1.12000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	6	2	1	55	6.90000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	6	2	1	56	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	56	1.11862+00	2.87426+00	1.00000+02	1.10000+02	2.30000+00	0.00000	0.00000
3	6	2	1	56	1.10000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	6	2	1	56	6.10000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	6	2	1	57	0.00000	2.55645+02	4.16753+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	57	1.11862+00	2.87426+00	1.00000+02	1.12000+02	2.50000+00	0.00000	0.00000
3	6	2	1	57	1.03400+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	3.00000+00
4	6	2	1	57	3.08000+02	0.00000	0.00000	2.00000+01	0.00000	0.00000	0.00000
1	6	2	1	58	0.00000	2.55645+02	4.16753+02	8.43840+05	1.60000+01	1.00000+00	0.00000
2	6	2	1	58	1.11862+00	2.87426+00	1.00000+02	1.12000+02	2.51000+00	0.00000	0.00000
3	6	2	1	58	6.89200+01	0.00000	8.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	6	2	1	58	2.08000+02	0.00000	0.00000	1.00000+01	0.00000	0.00000	0.00000
1	6	2	1	59	0.00000	1.82574+02	2.97699+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	59	1.11862+00	2.87426+00	7.14300+01	1.10500+02	2.18000+00	0.00000	0.00000
3	6	2	1	59	1.02000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	3.00000+00
4	6	2	1	59	3.30000+02	0.00000	0.00000	4.00000+01	0.00000	0.00000	0.00000
1	6	2	1	60	0.00000	1.09606+02	1.78613+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	60	1.11862+00	2.87426+00	4.28600+01	1.11900+02	2.45000+00	0.00000	0.00000
3	6	2	1	60	1.03300+02	2.60000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	6	2	1	60	2.67000+02	0.00000	0.00000	3.50000+01	0.00000	0.00000	0.00000

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	6	2	1	61	0.00000	1.09503+02	1.78455+02	8.43840+05	2.40000+01	1.00000+00	0.00000
2	6	2	1	61	1.11862+00	2.87426+00	4.28200+01	1.05600+02	1.23000+00	0.00000	0.00000
3	6	2	1	61	9.74800+01	2.60000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	6	2	1	61	5.70000+01	0.00000	0.00000	6.00000+01	0.00000	0.00000	0.00000
1	7	2	1	62	0.00000	2.68065+02	2.04197+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	7	2	1	62	2.43840+00	2.13360+00	1.00000+02	1.09300+02	1.95000+00	0.00000	0.00000
3	7	2	1	62	8.19500+01	4.00000+00	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	7	2	1	62	3.44000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	1	63	0.00000	2.68065+02	2.04197+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	7	2	1	63	2.43840+00	2.13360+00	1.00000+02	1.19200+02	3.65000+00	0.00000	0.00000
3	7	2	1	63	5.96100+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	7	2	1	63	1.35000+02	0.00000	0.00000	8.70000+01	0.00000	0.00000	0.00000
1	7	2	1	64	0.00000	2.68065+02	2.04197+02	5.69006+05	1.00000+01	1.00000+00	0.00000
2	7	2	1	64	2.43840+00	2.13360+00	1.00000+02	1.08700+02	1.85000+00	0.00000	0.00000
3	7	2	1	64	6.79400+01	0.00000	2.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	7	2	1	64	1.93000+02	0.00000	0.00000	1.75000+02	0.00000	0.00000	0.00000
1	7	2	1	65	0.00000	2.68065+02	2.04197+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	7	2	1	65	2.43840+00	2.13360+00	1.00000+02	1.16400+02	3.20000+00	0.00000	0.00000
3	7	2	1	65	5.81800+01	4.00000+00	4.00000+00	0.00000	0.00000	4.00602+01	8.00000+00
4	7	2	1	65	1.34000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	1	66	0.00000	9.04590+01	6.89278+01	5.69006+05	1.20000+01	1.00000+00	0.00000
2	7	2	1	66	2.43840+00	2.13360+00	3.37500+01	1.45100+02	6.95000+00	0.00000	0.00000
3	7	2	1	66	1.45100+02	3.80000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	7	2	1	66	1.34000+02	0.00000	0.00000	1.30000+01	0.00000	0.00000	0.00000
1	7	2	1	67	0.00000	9.04590+01	6.89278+01	5.69006+05	1.20000+01	1.00000+00	0.00000
2	7	2	1	67	2.43840+00	2.13360+00	3.37500+01	1.09600+02	2.05000+00	0.00000	0.00000
3	7	2	1	67	1.09600+02	3.60000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	7	2	1	67	3.30000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	2	1	68	0.00000	2.22318+02	1.69338+02	5.69006+05	1.00000+01	1.00000+00	0.00000
2	7	2	1	68	2.43840+00	2.13360+00	8.29200+01	1.19300+02	3.70000+00	0.00000	0.00000
3	7	2	1	68	7.45600+01	5.00000+00	2.00000+00	0.00000	0.00000	4.00602+01	8.00000+00
4	7	2	1	68	2.10000+02	0.00000	0.00000	6.00000+01	0.00000	0.00000	0.00000
1	8	2	1	69	0.00000	2.22318+02	1.69338+02	5.69006+05	8.00000+00	1.00000+00	0.00000
2	8	2	1	69	2.43840+00	2.13360+00	8.29200+01	1.20400+02	3.82000+00	0.00000	0.00000
3	8	2	1	69	6.01800+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	4.00000+00
4	8	2	1	69	1.04000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	2	1	70	0.00000	9.04590+01	6.89278+01	5.69006+05	1.20000+01	1.00000+00	0.00000
2	8	2	1	70	2.43840+00	2.13360+00	3.37500+01	1.33000+02	5.65000+00	0.00000	0.00000
3	8	2	1	70	1.33000+02	5.20000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	8	2	1	70	1.25000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-6. (Concluded)

HORIZONTALLY OPPOSED GAS FIRED BOILERS

1	8	2	1	71	0.00000	9.04590+01	6.89278+01	5.69006+05	1.20000+01	1.00000+00	0.00000
2	8	2	1	71	2.43840+00	2.13360+00	3.37500+01	1.44000+02	6.95000+00	0.00000	0.00000
3	8	2	1	71	1.08300+02	2.70000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	8	2	1	71	9.90000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	2	1	72	0.00000	2.68065+02	2.04197+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	8	2	1	72	2.43840+00	2.13360+00	1.00000+02	1.10000+02	2.10000+00	0.00000	0.00000
3	8	2	1	72	8.25000+01	0.00000	0.00000	0.00000	0.00000	4.00602+01	3.00000+00
4	8	2	1	72	3.26000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	2	1	73	0.00000	2.01101+02	1.53155+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	8	2	1	73	2.43840+00	2.13360+00	7.50000+01	1.08700+02	1.85000+00	0.00000	0.00000
3	8	2	1	73	8.15300+01	1.20000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	8	2	1	73	1.86000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	8	2	1	74	0.00000	2.01101+02	1.53155+02	5.69006+05	1.20000+01	1.00000+00	0.00000
2	8	2	1	74	2.43840+00	2.13360+00	7.50000+01	1.11600+02	2.40000+00	0.00000	0.00000
3	8	2	1	74	8.37200+01	1.00000+01	0.00000	0.00000	0.00000	4.00602+01	7.00000+00
4	8	2	1	74	2.30000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE C-7. NO_x CONTROL TEST DATA FROM SINGLE WALL GAS-FIRED BOILERS

1	1	3	1	1	0.00000	2.59992+02	2.52399+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	1	1	0.00000	0.00000	1.01700+02	1.13900+02	2.78000+00	0.00000	0.00000
3	1	3	1	1	1.13900+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	1	3.87000+02	0.00000	0.00000	1.40000+01	0.00000	0.00000	0.00000
1	1	3	1	2	0.00000	2.63097+02	2.55396+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	1	2	0.00000	0.00000	1.02900+02	1.05300+02	1.15000+00	0.00000	0.00000
3	1	3	1	2	1.05300+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	2	3.31000+02	0.00000	0.00000	8.40000+01	0.00000	0.00000	0.00000
1	1	3	1	3	0.00000	2.59992+02	2.52399+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	1	3	0.00000	0.00000	1.01700+02	1.04700+02	1.05000+00	0.00000	0.00000
3	1	3	1	3	1.01700+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	3	3.34000+02	0.00000	0.00000	5.40000+01	0.00000	0.00000	0.00000
1	1	3	1	4	0.00000	2.59992+02	2.52399+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	4	0.00000	0.00000	1.01700+02	1.15600+02	3.08000+00	0.00000	0.00000
3	1	3	1	4	8.67000+01	0.00000	4.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	4	2.01000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	1	3	1	5	0.00000	2.61027+02	2.53408+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	5	0.00000	0.00000	1.02100+02	1.04800+02	1.05000+00	0.00000	0.00000
3	1	3	1	5	7.86000+01	0.00000	4.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	5	1.56000+02	0.00000	0.00000	5.00000+01	0.00000	0.00000	0.00000
1	1	3	1	6	0.00000	2.61027+02	2.53408+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	6	0.00000	0.00000	1.02100+02	1.16600+02	3.23000+00	0.00000	0.00000
3	1	3	1	6	8.74000+01	0.00000	4.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	6	1.95000+02	0.00000	0.00000	1.60000+01	0.00000	0.00000	0.00000
1	1	3	1	7	0.00000	1.61874+02	1.57193+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	1	7	0.00000	0.00000	6.33300+01	1.11000+02	2.35000+00	0.00000	0.00000
3	1	3	1	7	1.11000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	7	2.30000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	1	3	1	8	0.00000	1.57630+02	1.53061+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	1	3	1	8	0.00000	0.00000	6.16700+01	1.05000+02	1.05000+00	0.00000	0.00000
3	1	3	1	8	1.05000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	8	1.88000+02	0.00000	0.00000	1.70000+01	0.00000	0.00000	0.00000
1	1	3	1	9	0.00000	1.58458+02	1.53881+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	9	0.00000	0.00000	6.20000+01	1.15600+02	3.08000+00	0.00000	0.00000
3	1	3	1	9	8.67000+01	0.00000	4.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	9	1.33000+02	0.00000	0.00000	1.50000+01	0.00000	0.00000	0.00000
1	1	3	1	10	0.00000	1.61874+02	1.57193+02	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	10	0.00000	0.00000	6.33300+01	1.05100+02	1.13000+00	0.00000	0.00000
3	1	3	1	10	7.89000+01	0.00000	4.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	10	8.80000+01	0.00000	0.00000	1.20000+02	0.00000	0.00000	0.00000

TABLE C-7. (Continued)

FRONT WALL GAS FIRED BOILERS

1	1	3	1	11	0.00000	8.95275+01	8.68774+01	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	11	0.00000	0.00000	3.50000+01	1.15000+02	3.05000+00	0.00000	0.00000
3	1	3	1	11	1.15000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	11	1.16000+02	0.00000	0.00000	1.30000+01	0.00000	0.00000	0.00000
1	1	3	1	12	0.00000	8.95275+01	8.68774+01	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	1	3	1	12	0.00000	0.00000	3.50000+01	1.06000+02	1.23000+00	0.00000	0.00000
3	1	3	1	12	1.06000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	1	3	1	12	1.08000+02	0.00000	0.00000	1.30000+01	0.00000	0.00000	0.00000
1	1	3	1	13	0.00000	8.95275+01	8.68774+01	4.70265+05	1.00000+01	1.00000+00	1.00000+00
2	1	3	1	13	0.00000	0.00000	3.50000+01	1.14400+02	2.88000+00	0.00000	0.00000
3	1	3	1	13	9.53000+01	0.00000	2.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	13	8.10000+01	0.00000	0.00000	1.60000+01	0.00000	0.00000	0.00000
1	1	3	1	14	0.00000	8.95275+01	8.68774+01	4.70265+05	1.00000+01	1.00000+00	1.00000+00
2	1	3	1	14	0.00000	0.00000	3.50000+01	1.08000+02	1.07000+00	0.00000	0.00000
3	1	3	1	14	9.00000+01	0.00000	2.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	1	3	1	14	6.60000+01	0.00000	0.00000	8.00000+01	0.00000	0.00000	0.00000
1	2	3	1	15	0.00000	2.58129+02	2.96058+02	2.54324+05	1.20000+01	1.00000+00	0.00000
2	2	3	1	15	0.00000	0.00000	9.13600+01	1.22500+02	4.18000+00	0.00000	0.00000
3	2	3	1	15	1.22500+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	3	1	15	4.97000+02	0.00000	0.00000	5.20000+01	0.00000	0.00000	0.00000
1	2	3	1	16	0.00000	2.58129+02	2.96058+02	2.54324+05	1.20000+01	1.00000+00	0.00000
2	2	3	1	16	0.00000	0.00000	9.13600+01	1.12700+02	2.59000+00	0.00000	0.00000
3	2	3	1	16	1.12700+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	3	1	16	4.21000+02	0.00000	0.00000	1.77000+02	0.00000	0.00000	0.00000
1	2	3	1	17	0.00000	2.58129+02	2.96058+02	2.54324+05	1.00000+01	1.00000+00	0.00000
2	2	3	1	17	0.00000	0.00000	9.13600+01	1.28300+02	5.03000+00	0.00000	0.00000
3	2	3	1	17	1.06900+02	0.00000	2.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	3	1	17	3.76000+02	0.00000	0.00000	5.60000+01	0.00000	0.00000	0.00000
1	2	3	1	18	0.00000	2.58129+02	2.96058+02	2.54324+05	1.00000+01	1.00000+00	0.00000
2	2	3	1	18	0.00000	0.00000	9.13600+01	1.13800+02	2.80000+00	0.00000	0.00000
3	2	3	1	18	9.49000+01	0.00000	2.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	3	1	18	3.11000+02	0.00000	0.00000	2.90000+02	0.00000	0.00000	0.00000
1	2	3	1	19	0.00000	6.10650+01	7.00004+01	2.54324+05	1.00000+01	1.00000+00	0.00000
2	2	3	1	19	0.00000	0.00000	2.16000+01	1.26000+02	4.65000+00	0.00000	0.00000
3	2	3	1	19	1.26000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	2	3	1	19	9.00000+01	0.00000	0.00000	5.20000+01	0.00000	0.00000	0.00000
1	2	3	1	20	0.00000	6.10650+01	7.00004+01	2.54324+05	1.00000+01	1.00000+00	0.00000
2	2	3	1	20	0.00000	0.00000	2.16000+01	1.18100+02	3.50000+00	0.00000	0.00000
3	2	3	1	20	9.84000+01	0.00000	2.00000+00	0.00000	0.00000	3.92769+01	2.00000+00
4	2	3	1	20	6.50000+01	0.00000	0.00000	2.10000+02	0.00000	0.00000	0.00000

FRONT WALL GAS FIRED BOILERS

1	3	3	1	21	0.00000	1.78020+02	2.48361+02	8.86032+05	2.40000+01	2.00000+00	0.00000
2	3	3	1	21	0.00000	0.00000	9.84100+01	1.24600+02	4.50000+00	0.00000	0.00000
3	3	3	1	21	1.24600+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	3	1	21	9.92000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	1	22	0.00000	1.80918+02	2.52367+02	8.86032+05	2.40000+01	2.00000+00	0.00000
2	3	3	1	22	0.00000	0.00000	1.00000+02	1.12600+02	2.40000+00	0.00000	0.00000
3	3	3	1	22	1.12600+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	3	1	22	9.31000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	1	23	0.00000	1.28650+02	1.79465+02	8.86032+05	2.05000+01	2.00000+00	0.00000
2	3	3	1	23	0.00000	0.00000	7.11100+01	1.25200+02	4.60000+00	0.00000	0.00000
3	3	3	1	23	1.06900+02	0.00000	3.50000+00	0.00000	0.00000	3.92769+01	2.10000+00
4	3	3	1	23	7.68000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	1	24	0.00000	1.27512+02	1.77856+02	8.86032+05	2.05000+01	2.00000+00	0.00000
2	3	3	1	24	0.00000	0.00000	7.04800+01	1.14000+02	2.90000+00	0.00000	0.00000
3	3	3	1	24	9.73800+01	0.00000	3.50000+00	0.00000	0.00000	3.92769+01	2.10000+00
4	3	3	1	24	5.15000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	1	25	0.00000	1.06812+02	1.49023+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	3	3	1	25	0.00000	0.00000	5.90500+01	1.39000+02	6.40000+00	0.00000	0.00000
3	3	3	1	25	1.39000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	3	1	25	5.15000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3	3	1	26	0.00000	1.06812+02	1.49023+02	8.86032+05	1.60000+01	2.00000+00	0.00000
2	3	3	1	26	0.00000	0.00000	5.90500+01	1.24000+02	4.40000+00	0.00000	0.00000
3	3	3	1	26	1.24000+02	0.00000	0.00000	0.00000	0.00000	3.92769+01	1.00000+00
4	3	3	1	26	5.29000+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	1	27	0.00000	1.97685+02	2.65427+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	4	3	1	27	2.43840+00	0.00000	1.00000+02	1.06000+02	1.35000+00	0.00000	0.00000
3	4	3	1	27	1.06000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	4	3	1	27	4.69900+02	0.00000	0.00000	6.41000+00	0.00000	0.00000	0.00000
1	4	3	1	28	0.00000	1.64772+02	2.21200+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	4	3	1	28	2.43840+00	0.00000	8.33300+01	1.06600+02	1.43000+00	0.00000	0.00000
3	4	3	1	28	1.06000+02	1.40000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	4	3	1	28	2.77800+02	0.00000	0.00000	9.20000+00	0.00000	0.00000	0.00000
1	4	3	1	29	0.00000	1.23579+02	1.65900+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	4	3	1	29	2.43840+00	0.00000	6.25000+01	1.10300+02	2.15000+00	0.00000	0.00000
3	4	3	1	29	1.10000+02	3.10000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	4	3	1	29	1.57600+02	0.00000	0.00000	9.55000+00	0.00000	0.00000	0.00000
1	4	3	1	30	0.00000	1.56492+02	2.10159+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	4	3	1	30	2.43840+00	0.00000	7.91700+01	1.13600+02	2.75000+00	0.00000	0.00000
3	4	3	1	30	7.60000+01	1.40000+01	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	4	3	1	30	2.77800+02	0.00000	0.00000	5.33000+01	0.00000	0.00000	0.00000

TABLE C-7. (Continued)

FRONT WALL GAS FIRED BOILERS

1	5	3	1	31	0.00000	2.01825+02	2.70948+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	5	3	1	31	2.43840+00	0.00000	1.02080+02	1.08700+02	1.85000+00	0.00000	0.00000
3	5	3	1	31	1.09000+02	8.00000+00	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	5	3	1	31	3.36500+02	0.00000	0.00000	3.76000+01	0.00000	0.00000	0.00000
1	5	3	1	32	0.00000	2.03481+02	2.73188+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	5	3	1	32	2.43840+00	0.00000	1.02920+02	1.11100+02	2.30000+00	0.00000	0.00000
3	5	3	1	32	7.40000+01	7.60000+00	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	5	3	1	32	1.11700+02	0.00000	0.00000	7.70000+01	0.00000	0.00000	0.00000
1	5	3	1	33	0.00000	1.97685+02	2.65427+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	5	3	1	33	2.43840+00	0.00000	1.00000+02	1.09500+02	2.00000+00	0.00000	0.00000
3	5	3	1	33	7.30000+01	9.00000+00	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	5	3	1	33	8.72000+01	0.00000	0.00000	2.60500+02	0.00000	0.00000	0.00000
1	5	3	1	34	0.00000	6.59295+01	8.84547+01	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	5	3	1	34	2.43840+00	0.00000	3.33300+01	1.17600+02	3.43000+00	0.00000	0.00000
3	5	3	1	34	7.80000+01	6.50000+01	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	5	3	1	34	5.22000+01	0.00000	0.00000	2.05000+01	0.00000	0.00000	0.00000
1	5	3	1	35	0.00000	8.23860+01	1.10600+02	5.17731+05	1.20000+01	1.00000+00	1.00000+00
2	5	3	1	35	2.43840+00	0.00000	4.16700+01	1.15000+02	3.00000+00	0.00000	0.00000
3	5	3	1	35	1.15000+02	5.60000+01	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	5	3	1	35	1.11000+02	0.00000	0.00000	4.00000+01	0.00000	0.00000	0.00000
1	6	3	1	36	0.00000	2.55645+02	2.48203+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	1	36	1.98120+00	0.00000	1.00000+02	1.09500+02	2.00000+00	0.00000	0.00000
3	6	3	1	36	8.20000+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	2.00000+00
4	6	3	1	36	1.43100+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	1	37	0.00000	2.55645+02	2.48203+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	1	37	1.98120+00	0.00000	1.00000+02	1.06700+02	1.45000+00	0.00000	0.00000
3	6	3	1	37	7.90000+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	2.00000+00
4	6	3	1	37	1.56500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	1	38	0.00000	2.11657+02	2.05458+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	6	3	1	38	1.98120+00	0.00000	8.27800+01	1.06400+02	1.40000+00	0.00000	0.00000
3	6	3	1	38	7.90000+01	3.50000+00	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	6	3	1	38	1.29500+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	6	3	1	39	0.00000	7.10010+01	6.89594+01	4.70265+05	8.00000+00	1.00000+00	1.00000+00
2	6	3	1	39	1.98120+00	0.00000	2.77800+01	1.14600+02	2.93000+00	0.00000	0.00000
3	6	3	1	39	8.60000+01	3.20000+01	2.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	6	3	1	39	6.08000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	1	40	0.00000	2.55645+02	2.48203+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	40	1.98120+00	0.00000	1.00000+02	1.14000+02	2.75000+00	0.00000	0.00000
3	7	3	1	40	1.14000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	7	3	1	40	3.71600+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

FRONT WALL GAS FIRED BOILERS

1	7	3	1	41	0.00000	2.57197+02	2.49686+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	41	1.98120+00	0.00000	1.00600+02	1.05000+02	1.13000+00	0.00000	0.00000
3	7	3	1	41	1.05000+02	0.00000	0.00000	0.00000	0.00000	4.00602+01	1.00000+00
4	7	3	1	41	3.14300+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	1	42	0.00000	2.49953+02	2.42683+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	42	1.98120+00	0.00000	9.77800+01	1.16800+02	3.30000+00	0.00000	0.00000
3	7	3	1	42	8.80000+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	2.00000+00
4	7	3	1	42	1.09800+02	0.00000	0.00000	6.10000+01	0.00000	0.00000	0.00000
1	7	3	1	43	0.00000	2.55645+02	2.48203+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	43	1.98120+00	0.00000	1.00000+02	1.04900+02	1.08000+00	0.00000	0.00000
3	7	3	1	43	7.80000+01	0.00000	4.00000+00	0.00000	0.00000	4.00602+01	2.00000+00
4	7	3	1	43	1.20200+02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	1	44	0.00000	1.71810+02	1.66846+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	44	1.98120+00	0.00000	6.72200+01	1.12000+02	2.33000+00	0.00000	0.00000
3	7	3	1	44	1.12000+02	4.00000+00	0.00000	0.00000	0.00000	4.00602+01	5.00000+00
4	7	3	1	44	2.67100+02	0.00000	0.00000	2.89000+01	0.00000	0.00000	0.00000
1	7	3	1	45	0.00000	1.70465+02	1.65458+02	4.70265+05	1.60000+01	1.00000+00	1.00000+00
2	7	3	1	45	1.98120+00	0.00000	6.66700+01	1.06100+02	1.33000+00	0.00000	0.00000
3	7	3	1	45	8.00000+01	4.00000+00	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	7	3	1	45	7.50000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	7	3	1	46	0.00000	8.51805+01	8.27134+01	4.70265+05	1.20000+01	1.00000+00	1.00000+00
2	7	3	1	46	1.98120+00	0.00000	3.33300+01	1.11200+02	2.33000+00	0.00000	0.00000
3	7	3	1	46	9.30000+01	5.00000+01	2.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	7	3	1	46	5.59000+01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	4	3	1	47	0.00000	1.89405+02	2.54355+02	5.17731+05	8.00000+00	1.00000+00	1.00000+00
2	4	3	1	47	2.43840+00	0.00000	9.58300+01	1.12400+02	2.55000+00	0.00000	0.00000
3	4	3	1	47	7.49400+01	1.20000+01	4.00000+00	0.00000	0.00000	4.00602+01	6.00000+00
4	4	3	1	47	1.15100+02	0.00000	0.00000	1.95100+01	0.00000	0.00000	0.00000

APPENDIX D

NO_x EMISSIONS CORRELATION: ANALYSIS OF VARIANCE

The correlation of NO_x emissions with boiler/burner design and operating variables by multiple regression analysis was presented in Section 4. The analysis of variance for the regression equations are given in Tables D-1 through D-7 of this appendix.

The multiple regression analysis was performed in a stepwise manner. The contribution of each variable towards explaining the total variance as it enters the regression equation and its corresponding partial F ratio are tabulated in the Analysis of Variance (ANOVA) tables. The variance explained by the final regression equation and its F ratio are also shown therein. The expression for NO_x emissions which best correlates the data is then given. Finally, the correlation coefficients and the standard error of the estimate are presented.

TABLE D-1. ANALYSIS OF VARIANCE: TANGENTIAL COAL-FIRED BOILERS

Second Order Multiple Regression Model

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	5	1447287.8	289457.6	80.1
x_2	1	1103214.2	1103214.2	305.2
x_1x_2/x_2	1	207911.3	207911.3	57.5
x_1x_2, x_1x_2	1	45190.1	45190.1	12.5
x_3x_4/x_2,x_1x_2,x_1	1	54471.1	54471.1	15.1
x_1^2/x_2,x_1x_2,x_1,x_3x_4	1	36501.1	36501.1	10.1
Residual	134	484385.3	3614.8	
Total	139	1931673.1		

Regression Equation:

$$y = 184.2 + 1.597\ (x_2) + 1.083 \times 10^{-7}\ (x_1)(x_2) - 1.673 \times 10^{-5}\ (x^1) + 2.494 \times 10^{-6}\ (x_3)(x_4) + 6.536 \times 10^{-14}\ (x_1)^2$$

where

y = NO_x emissions, ppm dry @ 3% O_2
x_1 = Heat input per active burner, W
x_2 = Stoichiometry to active burners, percent
x_3 = Surface heat release rate, W/m^2
x = Furnace stoichiometry, percent

Correlation coefficient = 0.866
Variation explained by regression = 74.9%
Standard of error of the estimate = 61 ppm

TABLE D-2. ANALYSIS OF VARIANCE: OPPOSED WALL COAL-FIRED BOILERS

First Order Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	6	832568.1	138761.4	36.4
x_1	1	583727.5	583727.5	153.3
x_2/x_1	1	54378.7	54378.7	14.3
$x_3/x_1,x_2$	1	112734.9	112734.9	29.6
$x_4/x_1,x_2,x_3$	1	22602.5	22602.5	5.9
$x_5/x_1,x_2,x_3,x_4$	1	33071.8	33071.8	8.7
$x_6/x_1,x_2,x_3,x_4,x_5$	1	26052.7	26052.7	6.8
Residual	46	175186.4	3808.4	
Total	52	1007754.8		

Regression Equation:

$$y = 470.5 + 5.378\,(x_1) + 4.24 \times 10^{-6}\,(x_1) + 7.41\,(x_3) - 5838\,(x_4) - 6.639 \times 10^{1}\,(x_5) + 2.463 \times 10^{1}\,(x_6)$$

where

y = NO_x Emissions, ppm dry @ 3% O_2
x_1 = Stoichiometry to active burners, percent
x_2 = Heat input per active burner, W
x_3 = Number of burners firing
x_4 = Flue gas recirculation
x_5 = Number of division walls
x_6 = Excess Oxygen

Correlation coefficient = 0.91
Variation explained by regression = 82.6%
Standard of error of the estimate = 62 ppm

TABLE D-3. ANALYSIS OF VARIANCE: SINGLE WALL COAL-FIRED BOILERS

Second Order Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	5	1149017.8	229803.6	61.0
x_2x_3	1	691878.5	691878.5	183.8
x_2x_4/x_2x_3	1	409677.2	409677.2	108.8
$x_1x_5/x_2x_3,x_2x_4$	1	26315.2	26315.2	7.0
$x_1x_1/x_2x_3,x_2x_4,x_1x_5$	1	9948.0	9948.0	2.6
$x_1x_2/x_2x_3,x_2x_4,x_1x_5,x_1x_4$	1	11198.9	11198.9	2.9
Residual	81	304997.5	3765.4	
Total	86	1454015.3		

Regression Equation:

$$y = 139.8 + 4.502 \times 10^{-6} (x_1)(x_2) + 1.978 \times 10^{-1} (x_2)(x_3) + 7.573 \times 10^{-8} (x_3)($$
$$- 1.023 \times 10^{-11}) (x_1)(x_4) + 6.948 \times 10^{-5} (x_1)(x_5)$$

where

y = NO_x emissions, ppm dry @ 3% O_2
x_1 = Surface heat release rate, W
x_2 = Stoichiometry to active burners, percent
x_3 = Number of burners firing
x_4 = Heat input per active burners, W
x_5 = Furnace excess oxygen, percent

Correlation coefficient = 0.889
Variation explained by regression = 79.0%
Standard of error of the estimate = 61.7 ppm

TABLE D-4. ANALYSIS OF VARIANCE: OPPOSED WALL OIL-FIRED BOILERS

Second Order Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	4	289322.0	72330.5	53.8
x_1x_2	1	174375.3	174375.3	129.6
x_3^2/x_1x_2	1	36357.0	36357.0	27.0
$x_1x_4/x_1x_2,x_3^2$	1	68805.5	68805.5	51.2
$x_5/x_1x_2,x_3^2,x_1x_4$	1	9784.2	9784.2	7.3
Residual	52	69940.4	1345.0	
Total	56	359262.4		

Regression Equation:

$$y = -228 + 1.046 \times 10^{-1} (x_1)(x_2) + 7.227 \times 10^{-3} (x_3)^2 - 1.301 (x_1)(x_4) + 2.392 (x_5)$$

where

y = NO_x Emissions, ppm dry @ 3% O_2
x_1 = Firing rate, percent
x_2 = Number of burners firing
x_3 = Stoichiometry to active burners
x_4 = Number of division walls
x_5 = Furnance stoichiometry, percent

Correlation coefficient = 0.897
Variation explained by regression = 80.5%
Standard of error of the estimate = 37 ppm

TABLE D-5. ANALYSIS OF VARIANCE: SINGLE WALL OIL-FIRED BOILERS

Second Order Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	5	290684.1	58136.8	24.1
x_1x_2	1	130627.9	130627.9	54.2
x_1/x_1x_2	1	131447.6	131447.6	54.6
$x_3x_4/x_1x_2,x_1$	1	9942.0	9942.0	4.1
$x_4x_5/x_1x_2,x_1,x_3x_4$	1	13118.5	13118.5	5.5
$x_4^2/x_1x_2,x_1x_3x_4,x_4x_5$	1	5548.1	5548.1	2.3
Residual	56	134892.4	2408.8	
Total	61	425576.5		

Regression Equation:

$$y = 172.7 + 2.283 \times 10^{-5} (x_1)(x_2) - 1.913 \times 10^{-3} (x_1) + 6.179 \times 10^{-8} (x_3)(x_4) - 9.406 \times 10^{-7}) (x_4)(x_5) + 3.602 \times 10^{-14} (x_4)^2$$

where

y = NO_x emissions, ppm dry @ 3% O_2
x_1 = Volumetric heat release rate, W
x_2 = Stoichiometry to active burners, percent
x_3 = Total furnace stoichiometry minus stoichiometry to active burners, percent
x_4 = Heat input per active burners, W
x_5 = Number of burners out of service

Correlation coefficient = 0.826
Variation explained by regression = 68.3%
Standard of error of the estimate = 49 ppm

TABLE D-6. ANALYSIS OF VARIANCE: OPPOSED WALL GAS-FIRED BOILERS

Logarithmic Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Total				

Regression Equation:

$$y = 4.42 \; (x_1)^{1.271} \; (x_2)^{2.496} \; (x_3)^{-2.665} \; (x_4)^{-0.2668} \; (x_5)^{-0.03517}$$

where

y = NO_x emissions, ppm dry @ 3% O_2
x_1 = Firing rate, percent
x_2 = Stoichiometry to active burner, percent
x_3 = Furnace stoichiometry, percent
x_4 = Number of furnace division walls plus one
x_5 = Flue gas recirculation plus one, percent

Correlation coefficient = 0.871
Variation explained by regression = 75.8%
Standard of error of the estimate = 107.2 ppm

TABLE D-7. ANALYSIS OF VARIANCE: SINGLE WALL GAS-FIRED BOILERS

Second Order Multiple Regression Model

Analysis of Variance:

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-Ratio
Regression	4	581913.3	145478.3	98.1
x_1x_2	1	499943.0	499943.0	337.3
x_1x_3/x_1x_2	1	75062.7	75062.7	50.6
$x_3/x_1x_2, x_1x_3$	1	3702.7	3702.7	2.5
$x_2x_4/x_1x_2, x_1x_3, x_3$	1	3204.9	3204.9	2.2
Residual	37	54846.0	1482.3	
Total	41	638747.5		

Regression Equation:

$$y = 37.2 + 1.448 \times 10^{-5} (x_1)(x_2) - 1.852 \times 10^{-4} (x_1)(x_3) + 2.089 \times 10^{1} (x_3) - 6.461 \times 10^{-3} (x_2)(x_4)$$

where

y = NO_x emissions, ppm dry @ 3% O_2
x_1 = Surface heat release rate, W
x_2 = Stoichiometry to active burners, percent
x_3 = Number of burners out of service
x_4 = Flue gas recirculation, percent

Correlation coefficient = 0.949
Variation explained by regression = 91.4%
Standard of error of the estimate = 39 ppm

APPENDIX E
INPUTS TO COST ANALYSIS CALCULATION ALGORITHM

Inputs to the cost analysis calculation algorithm described in Section 6.2 and typical control cases presented in Section 6.3 are listed in this appendix. Table E-1 is a glossary of terms used in the cost analysis computer code, while Tables E-2 through E-7 list the inputs for each of the control cases treated.

TABLE E-1. GLOSSARY OF TERMS USED IN COST ANALYSIS CALCULATION ALGORITHM

AKW	=	Additional Fan Power Requirements, kW
AROY	=	Annual Royalties, $/yr
B1	=	Debt/Equity Ratio, fraction
CANAL	=	Cost per Analysis, $
CF1	=	Construction Facilities Factor, fraction
CFE1	=	Construction Field Expense Factor, fraction
CGA	=	Construction General & Administrative Expense, fraction
CON1	=	Contractor's Fee, fraction
CRATE	=	Composite Construction Crew Rate, $/h
CSUPV	=	Construction Supervision Factor, fraction
CTN1	=	Construction Contingency Factor, fraction
DESRAT	=	Designer's Rate, $/h
DHRS	=	Design Hours, h
DRATE	=	Derate of Boiler, kW
DS1	=	Engineering Design and Supervision Factor, fraction
EGA	=	Engineering and Design G&A, fraction
EHRS	=	Engineering Hours, h
EOHD	=	Engineering and Design Overhead, fraction
EOOS	=	Equipment Out of Service, $
ER	=	Electric Power Rate, $/kWh
ERAT	=	Engineering Rate, $/hr
ESUPV	=	Engineering Supervision Factor, fraction
F1	=	Federal Tax Rate, fraction
FCOST	=	Fuel Cost, $/$10^6$ Btu (1 Btu = 1.055 kJ)
FEER	=	Engineering Fee, fraction
FPEN	=	Fuel Penalty, fraction
HRATE	=	Heat Rate of Boiler, Btu/kWh (1 Btu = 1.055 kJ)
HRINST	=	Installation Time, h
HYR	=	Annual Operation Time, h
IC	=	Initial Charges, $
IIO	=	Initial Investment of Boiler, $
ILAST	=	Computer Code Counter
IN1	=	Insurance Factor, fraction
IO1	=	Interest on Borrowed Money, Original Investment, fraction

TABLE F-1. (Concluded)

I1	=	Interest on Borrowed Money, Present Investment, fraction
K	=	Age of Existing Boiler, yr
KW	=	Power Rating of Boiler, kW
M1	=	Maintenance Factor, fraction
N	=	Remaining Lifetime of Boiler, yr
NANAL	=	Number of Analyses Required
NLOST	=	Total Lifetime of Boiler, yr
NOBASE	=	Baseline NO_x Emissions, ppm
NOCONT	=	Controlled NO_x Emissions, ppm
NOP	=	Number of Operators
OHA1	=	Administrative Overhead Operating Labor Factor, fraction
OHP1	=	Power Plant Overhead, fraction
PPR	=	Purchased Power Rate, $/kWh
RE1	=	Replacement Equipment Factor, fraction
RM	=	Raw Materials, $/yr
RO1	=	Return to Equity, Original Investment, fraction
R1	=	Return to Equity, Present Investment, fraction
SC1	=	Startup Cost Factor, fraction
SF1	=	Service Facilities Factor, fraction
S1	=	State Tax Rate, fraction
TM	=	Total Materials (Hardware) Required, $
UF1	=	Utilities Facilities Factor, fraction
WAGE	=	Operating Labor Rate, $/h

TABLE E-2. COST INPUTS FOR RETROFIT OFA FOR TANGENTIAL COAL-FIRED BOILER

AKW	=	.38200000E+03
AROY	=	.00000000E+00
B1	=	.50000000E+00
CANAL	=	.00000000E+00
CFE1	=	.13000000E+00
CF1	=	.50000000E-01
CGA	=	.25000000E+00
CON1	=	.70000000E-01
CRATE	=	.15300000E+02
CSUPV	=	.10000000E+00
CTN1	=	.11000000E+00
DESRAT	=	.90000000E+01
DHRS	=	.60000000E+03
DRATE	=	.00000000E+00
DS1	=	.00000000E+00
EGA	=	.25000000E+00
EHRS	=	.24000000E+03
EOHD	=	.11000000E+01
EOOS	=	.00000000E+00
ER	=	.25000000E-01
ERAT	=	.12000000E+02
ESUPV	=	.10000000E+00
FCOST	=	.13000000E+01
FEER	=	.80000000E-01
FPEN	=	.00000000E+00
F1	=	.48000000E+00
HRATE	=	.92000000E+04
HRINST	=	.35300000E+04
HYR	=	.70000000E+04
IC	=	.00000000E+00
IIO	=	.32600000E+08
ILAST	=	+0
IN1	=	.50000000E-02
IO1	=	.80000000E-01
I1	=	.80000000E-01
K	=	+5
KW	=	.22500000E+06
M1	=	.50000000E-01
N	=	+25
NANAL	=	.00000000E+00
NLOST	=	.30000000E+02
NOBASE	=	.45500000E+03
NOCONT	=	.31000000E+03
NOP	=	.00000000E+00
OHA1	=	.10000000E+00
OHP1	=	.20000000E+00
RE1	=	.40000000E-02
RM	=	.00000000E+00
RO1	=	.12000000E+00
R1	=	.12000000E+00
SC1	=	.10000000E+00
SF1	=	.50000000E-01
S1	=	.60000000E-01
PPR	=	.26000000E-01
TM	=	.31903000E+05
UF1	=	.30000000E-01
WAGE	=	.10000000E+02

TABLE E-3. COST INPUTS FOR RETROFIT OFA FOR OPPOSED WALL COAL-FIRED BOILER

AKW	=	.91800000E+03	HYR	=	.70000000E+04
AROY	=	.00000000E+00	IC	=	.00000000E+00
B1	=	.50000000E+00	IIO	=	.00000000E+00
CANAL	=	.00000000E+00	ILAST	=	+0
CFE1	=	.13000000E+00	IN1	=	.50000000E-02
CF1	=	.50000000E-01	IO1	=	.80000000E-01
CGA	=	.25000000E+00	I1	=	.80000000E-01
CON1	=	.70000000E-01	K	=	+5
CRATE	=	.15300000E+02	KW	=	.54000000E+06
CSUPV	=	.10000000E+00	M1	=	.50000000E-01
CTN1	=	.11000000E+00	N	=	+25
DESRAT	=	.90000000E+01	NANAL	=	.00000000E+00
DHRS	=	.70000000E+03	NLOST	=	.30000000E+02
DRATE	=	.00000000E+00	NOBASE	=	.78500000E+03
DS1	=	.00000000E+00	NOCONT	=	.55000000E+03
EGA	=	.25000000E+00	NOP	=	.00000000E+00
EHRS	=	.30000000E+03	OHA1	=	.10000000E+00
EOHD	=	.11000000E+01	OHP1	=	.20000000E+00
EOOS	=	.00000000E+00	RE1	=	.40000000E-02
ER	=	.25000000E-01	RM	=	.00000000E+00
ERAT	=	.12000000E+02	RO1	=	.12000000E+00
ESUPV	=	.10000000E+00	R1	=	.12000000E+00
FCOST	=	.13000000E+01	SC1	=	.10000000E+00
FEER	=	.80000000E-01	SF1	=	.50000000E-01
FPEN	=	.25000000E-02	S1	=	.60000000E-01
F1	=	.48000000E+00	PPR	=	.26000000E-01
HRATE	=	.92000000E+04	TM	=	.66073000E+05
HRINST	=	.56130000E+04	UF1	=	.30000000E-01
			WAGE	=	.10000000E+02

TABLE E-4. COST INPUTS FOR RETROFIT LOW NO_x BURNERS FOR OPPOSED WALL COAL-FIRED BOILER

AKW	=	.00000000E+00	HYR	=	.70000000E+04
AROY	=	.00000000E+00	IC	=	.00000000E+00
B1	=	.50000000E+00	IIO	=	.00000000E+00
CANAL	=	.00000000E+00	ILAST	=	+0
CFE1	=	.13000000E+00	IN1	=	.50000000E-02
CF1	=	.50000000E-01	IO1	=	.80000000E-01
CGA	=	.25000000E+00	I1	=	.80000000E-01
CON1	=	.70000000E-01	K	=	+5
CRATE	=	.15300000E+02	KW	=	.54000000E+06
CSUPV	=	.10000000E+00	M1	=	.50000000E-01
CTN1	=	.11000000E+00	N	=	+25
DESRAT	=	.90000000E+01	NANAL	=	.00000000E+00
DHRS	=	.40000000E+03	NLOST	=	.30000000E+02
DRATE	=	.00000000E+00	NOBASE	=	.78500000F+03
DS1	=	.00000000E+00	NOCONT	=	.39000000E+03
EGA	=	.25000000E+00	NOP	=	.00000000E+00
EHRS	=	.15000000E+03	OHA1	=	.10000000E+00
EOHD	=	.11000000E+01	OHP1	=	.20000000E+00
EOOS	=	.00000000E+00	RE1	=	.40000000E-02
ER	=	.25000000E-01	RM	=	.00000000E+00
ERAT	=	.12000000E+02	RO1	=	.12000000E+00
ESUPV	=	.10000000E+00	R1	=	.12000000E+00
FCOST	=	.13000000E+01	SC1	=	.10000000F+00
FEER	=	.80000000E-01	SF1	=	.50000000E-01
FPEN	=	.00000000E+00	S1	=	.60000000E-01
F1	=	.48000000E+00	PPR	=	.26000000E-01
HRATE	=	.92000000E+04	TM	=	.33600000E+06
HRINST	=	.15360000E+05	UF1	=	.30000000E-01
			WAGE	=	.10000000E+02

TABLE E-5. COST INPUTS FOR BURNERS OUT OF SERVICE FOR OPPOSED WALL COAL-FIRED BOILER

AKW	=	.00000000E+00	HYR	=	.70000000E+04
AROY	=	.00000000E+00	IC	=	.00000000E+00
B1	=	.50000000E+00	IIO	=	.83700000E+08
CANAL	=	.00000000E+00	ILAST	=	+0
CFE1	=	.13000000E+00	IN1	=	.50000000E-02
CF1	=	.50000000E-01	IO1	=	.80000000E-01
CGA	=	.25000000E+00	I1	=	.80000000E-01
CON1	=	.70000000E-01	K	=	+5
CRATE	=	.15300000E+02	KW	=	.54000000E+06
CSUPV	=	.10000000E+00	M1	=	.50000000E-01
CTN1	=	.11000000E+00	N	=	+25
DESRAT	=	.90000000E+01	NANAL	=	.00000000E+00
DHRS	=	.50000000E+02	NLOST	=	.30000000E+02
DRATE	=	.10800000E+06	NOBASE	=	.78500000E+03
DS1	=	.00000000E+00	NOCONT	=	.51000000E+03
EGA	=	.25000000E+00	NOP	=	.00000000E+00
EHRS	=	.64000000E+03	OHA1	=	.10000000E+00
EOHD	=	.11000000E+01	OHP1	=	.20000000E+00
EOOS	=	.00000000E+00	RE1	=	.40000000E-02
ER	=	.25000000E-01	RM	=	.00000000E+00
ERAT	=	.12000000E+02	RO1	=	.12000000E+00
ESUPV	=	.10000000E+00	R1	=	.12000000E+00
FCOST	=	.13000000E+01	SC1	=	.10000000E+00
FEER	=	.80000000E-01	SF1	=	.50000000E-01
FPEN	=	.25000000E-02	S1	=	.60000000E-01
F1	=	.48000000E+00	PPR	=	.26000000E-01
HRATE	=	.92000000E+04	TM	=	.00000000E+00
HRINST	=	.24000000E+03	UF1	=	.30000000E-01
			WAGE	=	.10000000E+02

TABLE E-6. COST INPUTS FOR BURNERS OUT OF SERVICE FOR SINGLE WALL OIL- AND GAS-FIRED BOILER

AKW	=	.00000000E+00	HYR	=	.70000000E+04
AROY	=	.00000000E+00	IC	=	.00000000E+00
B1	=	.50000000E+00	IIO	=	.00000000E+00
CANAL	=	.00000000E+00	ILAST	=	+0
CFE1	=	.13000000E+00	IN1	=	.50000000E-02
CF1	=	.50000000E-01	IO1	=	.80000000E-01
CGA	=	.25000000E+00	I1	=	.80000000E-01
CON1	=	.70000000E-01	K	=	+5
CRATE	=	.15300000E+02	KW	=	.90000000E+05
CSUPV	=	.10000000E+00	M1	=	.50000000E-01
CTN1	=	.11000000E+00	N	=	+25
DESRAT	=	.90000000E+01	NANAL	=	.00000000E+00
DHRS	=	.30000000E+02	NLOST	=	.30000000E+02
DRATE	=	.00000000E+00	NOBASE	=	.35500000E+03
DS1	=	.00000000E+00	NOCONT	=	.21000000E+03
EGA	=	.25000000E+00	NOP	=	.00000000E+00
EHRS	=	.50000000E+03	OHA1	=	.10000000E+00
EOHD	=	.11000000E+01	OHP1	=	.20000000E+00
EOOS	=	.00000000E+00	RE1	=	.40000000E-02
ER	=	.25000000E-01	RM	=	.00000000E+00
ERAT	=	.12000000E+02	RO1	=	.12000000E+00
ESUPV	=	.10000000E+00	R1	=	.12000000E+00
FCOST	=	.27000000E+01	SC1	=	.10000000E+00
FEER	=	.80000000E-01	SF1	=	.50000000E-01
FPEN	=	.25000000E-02	S1	=	.60000000E-01
F1	=	.48000000E+00	PPR	=	.26000000E-01
HRATE	=	.92000000E+04	TM	=	.00000000E+00
HRINST	=	.16000000E+03	UF1	=	.30000000E-01
			WAGE	=	.10000000E+02

TABLE E-7. COST INPUTS FOR RETROFIT FGR/OFA, FOR SINGLE WALL OIL- AND GAS-FIRED BOILER

AKW	=	.45000000E+03	HYR	=	.70000000E+04
AROY	=	.00000000E+00	IC	=	.00000000E+00
B1	=	.50000000E+00	IIO	=	.00000000E+00
CANAL	=	.00000000E+00	ILAST	=	+0
CFE1	=	.13000000E+00	IN1	=	.50000000E-02
CF1	=	.50000000E-01	IO1	=	.80000000E-01
CGA	=	.25000000E+00	I1	=	.80000000E-01
CON1	=	.70000000E-01	K	=	+5
CRATE	=	.15300000E+02	KW	=	.90000000E+05
CSUPV	=	.10000000E+00	M1	=	.50000000E-01
CTN1	=	.11000000E+00	N	=	+25
DESRAT	=	.90000000E+01	NANAL	=	.00000000E+00
DHRS	=	.80000000E+03	NLOST	=	.30000000E+02
DRATE	=	.00000000E+00	NOBASE	=	.35500000E+03
DS1	=	.00000000E+00	NOCONT	=	.15500000E+03
EGA	=	.25000000E+00	NOP	=	.00000000E+00
EHRS	=	.29000000E+03	OHA1	=	.10000000E+00
EOHD	=	.11000000E+01	OHP1	=	.20000000E+00
EOOS	=	.00000000E+00	RE1	=	.40000000E-02
ER	=	.25000000E-01	RM	=	.00000000E+00
ERAT	=	.12000000E+02	RO1	=	.12000000E+00
ESUPV	=	.10000000E+00	R1	=	.12000000E+00
FCOST	=	.27000000E+01	SC1	=	.10000000E+00
FEER	=	.80000000E-01	SF1	=	.50000000E-01
FPEN	=	.50000000E-02	S1	=	.60000000E-01
F1	=	.48000000E+00	PPR	=	.26000000E-01
HRATE	=	.92000000E+04	TM	=	.19485000E+06
HRINST	=	.46120000E+04	UF1	=	.30000000F-01
			WAGE	=	.10000000E+02

APPENDIX F
CONVERSION FACTORS

To Obtain	From	Multiply By
ng/J	lb/10^6 Btu	430
ng/J NO_x (as NO_2)	NO_x ppm @ 3% O_2 dry	0.510 (natural gas)*
ng/J NO_x (as NO_2)	NO_x ppm @ 3% O_2 dry	0.561 (oil)*
ng/J NO_x (as NO_2)	NO_x ppm @ 3% O_2 dry	0.611 (coal)*
NO_x ppm @ 3% O_2 dry	NO_x ppm dry	$\frac{17.9}{20.9 - \%\ O_2\ \text{dry}}$

*These approximate factors used only when data were otherwise insufficient.

Reference:

Maloney, K. L., et al., "Low-Sulfur Western Coal Use in Existing Small and Intermediate-Sized Boilers," EPA-600/7-78-153a, July 1978.

APPENDIX G
LIST OF ABBREVIATIONS

AH	Air heater
BBF	Biased burner firing
BOOS	Burners out of service
DMEG	Discharge multimedia environmental goals
DS	Discharge severity
EA	Environmental assessment
FD	Forced draft
FGR	Flue gas recirculation
FGT	Flue gas treatment
HC	Hydrocarbon
ID	Induced draft
LEA	Low excess air
LNB	Low NO_x burner
MCR	Maximum continuous rating
MEG	Multimedia environmental goal
NO_x	Nitrogen oxides
NSPS	New Source Performance Standard
OFA	Overfire air
OSC	Off stoichiometric combustion
PAH (PNA)	Polynuclear aromatic hydrocarbon (same as POM below)
POM	Polycyclic organic matter
RAP	Reduced (combustion) air preheat
RH	Reheater
SAM	Source analysis model
SCR	Selective catalytic reduction
SH	Superheater

TWDS	Total weighted discharge severity
UHC	Unburned hydrocarbon
WDS	Weighted discharge severity
WI	Water injection